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WOUNDS IN MODERN WAR *

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It is a great honor and privilege to address this Association but it is also a heavy responsibility. Though I may bring you little that is new, I speak for an enthusiastic contingent of Canadian surgeons who for two and a half years have devoted much time and thought to the practice of military surgery. I know that in extending an invitation to me you are doing honor to that group.

When we went to war in September 1939, many of us thought in terms of 1918. It was only natural that we should; for twenty years we had put fighting and its problems from our minds. It is not altogether an advantage to a nation to have a background of war at twenty years' distance when it faces another struggle. In every branch of the service, men recalled the campaigns of France, of Gallipoli, of Arabia. It may be that we shall be best served when we rid ourselves of the traditions of those years. Two decades between wars is a tragic interval. It is short enough to maintain continuity of thought and memory of past experience; it is too long amid the false security of peace for serious contemplation of the inevitable advances of military strategy that occur in the war-minded nation. Experience gained in the last war, unless it is subject to revision and development, may be a handicap rather than an advantage under these circumstances. There is needed not only the inflexible determination of purpose—perhaps more commonly the attribute of middle age—but also the elasticity of mind, the fashioning of new tools, and the adroit adaptation to new methods—surely the qualities of youth. This is a young man's war.

The management of wounds presents the same problems today as it

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has through the generations of military surgery,—the treatment of shock and hemorrhage and the prevention of infection. Down through the years, the question of transportation of the wounded has become increasingly difficult, and much time and effort have been spent on the problem of getting the wounded man to the surgeon. With the advent of *Blitzkrieg* it became well-nigh impossible to get the wounded back to the surgeon at any organized hospital, except with the aid of air ambulances. There is no doubt that this method of transportation is ideal. Two essentials are necessary, however. Air ambulances are relatively slow and, therefore, very vulnerable to fighter attack, so that well-protected landing fields must be found in the vicinity of the battlefield, and the force using them must have superiority in the air. In a fast-moving campaign it is unlikely that both of these essentials will be available. The distances covered by mobile fighting columns in modern war may take them in one day completely out of reach of casualty clearing stations or evacuation centers which are organized on the 1918 model. Moreover, the terrain and roads leading back from the front may well be blocked by the stream of upgoing traffic in guns, rations, reinforcements, ammunition, and petrol. It is obvious, then, that the surgeon must be brought forward to the rear of the battle area if that early treatment which is essential to saving life and limb is to be provided.

THE MOBILE SURGICAL UNIT

Mobile warfare has presented a new problem to the surgeon; he must put himself, his assistants, and the essentials of equipment into vehicles which can move as quickly as the armored divisions which he serves. He must be prepared to set up his theater in whatever shelter he can find, and to do it quickly. He must be able to disband it rapidly and to move forward to another area on short notice; unfortunately, sometimes he must be ready to move it rearward out of enemy hands when the battle sways against his comrades. Neither the British nor the Canadian Armies had a unit in the beginning of the war which fitted into such a scheme. The field ambulances had been mechanized, but they lacked operating equipment. Their duties were those of collecting and evacuating. The casualty clearing station was the first organized operating center, and it lacked the necessary mobility.

In the East African and Libyan campaigns the personnel of the field ambulances found themselves faced with the responsibility of forward operating units, and often with limited equipment. As a sequel to this, mobile operating teams were formed at army headquarters. The personnel consisted of two surgeons, sometimes an anaesthetist, and two or three theater orderlies. Their equipment was carried in two lorries, and they frequently set up their post at the main dressing station of a field ambulance.

The Canadian Army has in the past few months authorized the for-

mation of certain mobile surgical units, with arrangements for adding others as needed. These, in short, consist of three trucks: one three-ton lorry, fitted with light generating apparatus, water tank, and compartments to hold operating equipment and supplies; another thirty-hundredweight truck with a penthouse, which carries baggage, blankets, and emergency rations; and, finally, a station wagon for the personnel. The personnel consists of two surgeons, one anaesthetist, two orderlies, and two sisters; the latter are to be allowed to go with the unit at the discretion of the Deputy Director of Medical Services of the Corps, and depending on the exigencies of the situation. If sisters do not accompany the team, their places are taken by two extra orderlies. Such a unit can be in a position to operate within half an hour of arrival and the securing of some sort of shelter. It carries sufficient sterile linen for from thirty to forty operations, blood substitutes, plaster-of-Paris, and operating equipment for general traumatic surgery. The author is convinced that something of this sort is the answer to the problem of providing early surgery for the wounded in this war.

The surgeon who works in such a mobile surgical team should be young and physically fit. He should be well trained in the surgery of trauma,—not merely trauma of the chest, or of the abdomen, or of extremities, but that of any part of the body. In the modern campaign there is no time to segregate special types of cases in the forward area. The surgeon in the mobile unit must be trained to handle quickly and efficiently the results of violent trauma of any part of the body. He and his associates must have practised working as a closely knit, efficient team.

In the forward area, there is little place for the specialist, unless he is a general surgeon with special knowledge. The serious problem is the treatment of multiple injuries,—an open fracture of an extremity plus a head wound; a fracture of the pelvis and a rupture of the urethra; a penetrating wound of the chest or abdomen and burns about the face and hands. The surgeon faced with these problems must be versatile, resourceful, and, above all, he must be able to estimate with despatch the most urgent cases, and to act quickly and skillfully. He should be able to recognize those patients who are beyond human aid, give them sedatives, and leave them, without the waste of valuable time which should be utilized for the saving of life and limb.

TREATMENT OF SHOCK

Shock, with or without gross blood loss, remains a first consideration in the treatment of wounds. Perhaps the greatest advance in the treatment of shock has resulted from the recognition that serum or plasma has all the necessary constituents to combat its effects. Serum, either in its concentrated form or in its powdered state, has the very great advantage of being easily transportable. It can be stored for long periods under varying climatic conditions. Plasma has the same constituents as serum,

plus fibrinogen and an anticoagulant. In its fluid form, it will not keep as long as serum. This is due partly to the fact that, in England at least, it has been prepared as a by-product of blood banks and usually not from fresh blood, but from those containers of bank blood which it is unwise to keep longer for administration as such.

In England, the civilian, naval, air force, and army organizations work in close association, using supplies from common sources. With an expeditionary army there is a formation known as a forward or intermediate transfusion depot, which carries supplies of donor blood and blood substitutes. The blood substitutes are shipped from the home base in Britain. In distant fields donor blood may be prepared in limited quantities in the area. With each casualty clearing station there is a transfusion or resuscitation officer who is skilled in the use of all these measures and who, with his truck, acts as a forward distributing center, as well as a supervisor of shock treatment. The mobile operating unit, however, has to be self-sufficient in this respect, and carries enough plasma and serum for from thirty to forty cases, and possibly the means for doing whole-blood transfusions from personnel in the area. The field ambulances also carry a supply of blood substitutes and a transfusion box with giving sets. B.L.B. oxygen masks and containers are supplied to field ambulances and the casualty clearing station. Every effort has been made to provide the means for treating shock as far forward as possible. There is no doubt that it has been of the greatest value. In England during the severe raids, large supplies of whole blood and plasma were used. Our experience was with supplies from the transfusion depots in our own areas. We concluded that, in those cases without great blood loss, plasma or serum is just as effective to combat shock as is whole blood. Our experience with serum was largely with the concentrated form rather than with the dried product. We felt that the latter, of which we had limited quantities, should be kept for severe emergencies such as invasion. In a limited number of cases, dried serum, properly reconstituted, seemed just as valuable as plasma.

The diagnosis of shock has been made on clinical grounds with lowering of the systolic blood pressure as the most important single guide as to its degree. Repeated hemoglobin estimations have for the most part been used as the measure of hemoconcentration. Hematocrit readings have presented some difficulties, because it is not always convenient in times of stress in a war hospital to have the routine estimations carried out when indicated.

Whole blood, usually bank blood, has been reserved for those cases in which there is severe loss of blood. In the Canadian military organization, with such available facilities, it is felt that shock can be, and is being, treated with a fair amount of success. With such adequate measures available for resuscitation, the surgeon is called upon to treat many more severe and complicated injuries which, without such advantages, would have been fatal.

CLOSED-PLASTER METHOD

During the last war, it was well established that if the wounded man was to be saved from gas gangrene, the surgeon must be on the spot in reasonable time, and he must be prepared to do an excision of devitalized soft tissue, particularly of muscle. If the patient escaped gas gangrene, however, he still had to face the perils of the streptococcus and the staphylococcus in the large open wounds. Carrel, Dakin, Taylor, and others devised methods for the continuous irrigation of such wounds with chlorine solutions. Towards the latter part of the war, Winnett Orr found that he could discontinue irrigation in certain of his cases, immobilize the site of injury, cover the wounded area with plaster-of-Paris, and send the patients from France to America without changing their dressings. These patients traveled very well, and their wounds on arrival looked remarkably healthy. He continued to use this method of treatment in osteomyelitis and compound fractures.

It is true that even in 1917 the treatment of wounds by the closed method was not new. The French surgeon, Larrey, working in the latter part of the eighteenth and the early nineteenth centuries, learned from his experience with the Napoleonic armies the virtues of irremovable or fixed dressings. Pirogoff, the famous Russian surgeon, used closed-plaster fixation of wounds in 1850. Another French surgeon, Ollier, in 1872, writing of the Franco-Prussian War, described irremovable occlusion as a general method of treatment of wounds and discussed its application to military surgery.

During the Spanish Civil War, Trueta used a procedure somewhat similar to that of Orr.

Petron, chief surgeon to the Black Sea Fleet, in a recent communication discussing the trends of surgery in the present campaign writes as follows: "The so-called solid-plaster-cast method of treating wounds complicating fractures has been widely applied with highly gratifying results. Soviet field surgeons apply the cast directly over the wound. Absolute rest for the wound and the fracture is assured and the removal of the patient is facilitated."

Importance of Rest in Wound Healing

The principle of rest in wound healing is on a sound scientific basis. It has been shown experimentally that organisms introduced into an animal's leg can, if the animal be allowed to move about normally, be isolated from the glands of the groin after a very short interval. If the limb be kept at rest, the time interval is much increased. The rate of lymph flow in the extremities is directly related to the degree of motion allowed in the limb. Circulation in the blood vascular system is efficient when the soft tissues are firmly and uniformly supported. Support and rest are the two necessities for the mobilization at the site of injury of the natural defences of the body against infection, and are, therefore, the requisites for healing.

The author had occasion to see, in March 1942, a patient who was wounded in 1918, and to review certain points of interest in his history.

The patient, an Englishman, was wounded by a shell fragment in the right buttock. The bone was not involved. Roentgenograms revealed no evidence of old injury or of infection. There was no indication of a sciatic-nerve lesion. The wound, therefore, involved only the soft tissues of the buttock, including the glutei. The patient reached a casualty clearing station some twelve hours after injury, and was operated upon. He was subsequently transferred to a large hospital in France, where he remained for six months. One or two drainage operations were performed during that interval. Dressings were changed three times a day, and the wound was "syringed". Following discharge from the hospital he attended an out-patient department for another six months. A very good result was obtained, and the patient is now a corporal in the Provost Corps in the Canadian Army.

It is interesting to contrast this case with that of a patient injured in the great air raid on Coventry, who suffered a bomb wound in exactly the same area and approximately of the same degree.

The patient's wound was explored, foreign bodies were removed, and a thorough débridement was carried out. He was then put in a plaster spica. He was in the hospital two months, during which time he had in all three changes of plaster and dressing. At the end of the third month he was able to return to his work in the factory.

The saving of time (the time of skilled labor is precious in England), the saving of material (gauze, wool, and bandages), and the saving in pain and discomfort to the patient hardly need comment. Our surgeons working in Coventry found that there was still a tendency at the emergency centers to close wounds. Those reaching them with sutures were all reopened, thoroughly explored and treated in a manner similar to the case illustrated.

Infection

In the last war, it was customary to redress wounds at various stages during the long and arduous journey from the regimental aid post to the base hospital,—in the field ambulance, perhaps first at their advance station, then at the main station, the casualty clearing station, the ambulance train, and finally at the base hospital.

The closer to the base, the greater was the prevalence of hemolytic streptococcus found in the wounds. Hare and others have shown that this organism finds its way into wounds, not from the skin of the patient, but from the ministrations of the attendants and dressers; from the air of the dressing stations and hospitals, where other infected wounds are being continually tended; from the soiled dressings which, even with the greatest care, distribute organisms throughout the air; from the blankets which cover such patients; from the dust which, in spite of precautions, is stirred by the inevitable movement in a busy ward.

Efforts are being made in England to combat this dustborne infection. Greater care is encouraged in dressing technique. In some hospitals the floors are treated with spindle oil in an effort to trap the dust. A method of treating blankets with minimal amounts of oil has been recommended, with the idea of lessening the danger of airborne infection.

It is universally agreed that the removal of dead muscle is the best prophylactic against gas gangrene, even in the light of work recently published on various chemical compounds used as local preventives. Surely then, in the light of these facts, a treatment which provides adequate prophylaxis against gas infection, admits of complete rest and support, necessitates few dressings, and, therefore, minimizes the possibility of airborne infection, is a rational method. Our experience supports that conclusion.

When we came abroad, some of our colleagues in Canada were most anxious that clinical investigation should be undertaken, by which we might determine the relative value of the irrigation treatment and the closed-plaster method. That has not been done. If our troops had been engaged in active fighting earlier in the war, as we certainly expected they would be, such an investigation might have been practical.

We began to adopt the closed-plaster treatment in the severe cases of wounds and compound fractures, and were so impressed by the results that the practice of irrigation and repeated dressings has now almost disappeared from all our military hospitals. The dressing carriage is no longer a very important vehicle. Large and difficult dressings are done as a rule in a dressing room in the ward, or in a small operating room reserved for such cases.

Chemotherapy

An effort was made last year in one of our hospitals to determine the value of chemotherapy in association with débridement and closed fixation. In a small number of cases (fifty) roughly half were treated by careful débridement and fixation; the other half, by débridement, chemotherapy, and fixation. There was no appreciable difference in the results or in the healing time. It is our conviction that in severe wounds the only sound prophylaxis is the careful removal of all devitalized soft tissue. No amount of chemotherapy, local or general, can be a substitute for surgical excision.

The attitude that the sulphonamides are the complete salvation and answer to all the hazards of war wounds, and that, once the magic powder has been dusted in, nothing more is necessary, is regrettable. Indeed, during the days of the severe air bombardment in England, evidence of such a conviction on the part of some of the casualty surgeons was noted. Patients with severe wounds were brought into the hospital after an interval of some days with gross infection, the notes showing that the wounds had been cleansed and sulphanilamide had been applied. Exploration of such wounds frequently showed deep pockets of infected blood clot beneath fascia and in some cases bits of battle dress or other clothing.

In no case are exploration, débridement, and decompression more urgent than in those wounds resulting from the casing of high-explosive aerial bombs. A small sharp fragment, traveling at high velocity, usually with a rotary motion, causes a relatively insignificant wound of entry, but may do extensive damage to muscles beneath. Trueta has pointed out

the necessity for thorough exploration in such cases, and our experience has confirmed his observations.

Closure of Wounds after Excision

There is a great desire on the part of surgeons when dealing with compound fractures, and indeed in extensive soft-tissue wounds, to complete the procedure by covering the area with skin,—in other words, to suture the wound. This desire has been stimulated by reports of cases treated successfully with the aid of a sulphonamide introduced before closing. It is not a policy to be encouraged when dealing with war wounds, particularly with compound fractures which are produced by missiles or external agents.

Reports from an area of active operations stress the fact that wounds sutured in the forward area have been badly septic on arrival at the base. The following communication from a consulting surgeon is an example: "A large number of wounds have been operated on in the forward area. The recognized débridement was carried out in as many early cases as possible. The wounds were saucerized, dusted with sulphanilamide, and packed lightly with vaselin gauze. All these cases did extremely well. Some wounds had been sutured, but, with the exception of a very few cases, were badly septic on arrival at the base, with sutures cutting out and the patient in pain from suppuration under tension. The question of tension in 'track' wounds was an important factor, especially when the track leads through a muscle mass as in the thigh. Operation entails enlargement of the skin wounds and incision of the deep fascia."

The Director of Medical Services for the Australian Forces in the Middle East circulated a memorandum which included the following recommendations: "That after excision, all wounds be left open and *no* attempt to suture be made, except in cases of gunshot wounds of the skull, thorax, abdomen, and large superficial joints. That after excision of wounds in muscular areas *no* buried catgut sutures be used; the only ligature material buried in the wound is that necessary to control hemorrhage."

A memorandum for circulation to the forward medical units with the Canadian Corps suggests that in the forward areas no wounds, except minor cuts, be closed. Prophylactic use of sulphanilamide, both locally and orally, is advised; the time and amount given is to be noted on the field medical card and rapid evacuation to a properly organized operating center is urged. The memorandum clearly states that the application or administration of a sulphonamide in no way lessens the urgency for rapid evacuation. Whatever the merits of closing wounds in civilian practice, one feels very strongly that there is little place for it in the treatment of war casualties. Necrosis of bone is the result of infection locked up in the closed wound, particularly if, when the infection has occurred, it is not drained adequately. In seventy-five cases of compound fracture, treated by excision, packing, and plaster fixation, we have seen no cases of necrosis due to infection. In the open wound, protective granulations quickly

cover the exposed bone at the base of the wound. In the closed wound, tension from serum and blood clot increases, and, if infection is present, it invades the fascial spaces, interfering with blood supply, and creates all the conditions which favor bone infection.

WOUNDS OF THE EXTREMITIES

In numbers at least, wounds of the extremities remain the greatest single problem in war surgery. Severe injuries to the soft tissues or bones and joints of the extremities form a very large part of the casualties. One surgeon has written that wounds of the extremities constitute 70 per cent. of the casualties. It is for this reason that field surgery is primarily the surgery of the extremities.

The handling of extremity wounds in battle depends upon the severity of the injury and the transportation facilities. Some of the wounded will be seen by their regimental medical officer. In these cases hemorrhage should be controlled, the wounds should be inspected and covered by sterile dressings, and splints should be applied to fractures. Morphine should be given as needed. Ordinary casualties are picked up at the regimental aid post by a detachment of the field ambulance and ultimately find themselves at a main dressing station. In mobile warfare many casualties are picked up by cruising vehicles of all sorts and brought back to the nearest aid post, be it regimental or otherwise. It has already been suggested that in mobile warfare experienced surgeons with adequate equipment should be available as far forward as what is known as the main dressing station of the field ambulance. Some of the casualties may be evacuated farther down the line after sulphanilamide has been applied to the wounds. This depends on the facilities for transportation. In certain circumstances air transportation may be available for seriously injured patients—notably those with wounds in the abdomen, head, and chest—after the necessary measures of resuscitation have been employed. The volume and extent of operating done in the forward area varies with the speed of the advance, the interference with communications, and the available shelter. Certainly, if limbs and life are to be saved, many penetrating wounds and compound fractures should be subjected to débridement and fixation. Whether this procedure be carried out here or in the comparative quiet of stations farther away from the line will depend on the violence of the fighting.

Essential Principles of Operative Treatment

Certain first principles of operative treatment should be recognized wherever the procedure is undertaken.

1. It is much simpler to operate expertly on the thigh and leg in cases of compound fracture if extension is applied as a first procedure; some sort of simple extension frame is necessary, which will allow the use of skeletal traction while the surgeon is operating and be adequate for the application of plaster with the minimum of assistance.

2. A thorough exposure of muscle and soft tissues is essential in wounds caused by bomb or shell fragments. The decompression of subfascial hematomata must be adequately carried out. Radical skin incision is unnecessary.

3. All devitalized muscle should be removed. The surgeon should bear in mind the blood supply of muscles like the sartorius and gracilis, and should remember that in wounds involving them it is frequently necessary to excise the whole muscle.

4. Foreign bodies, such as bomb fragments or bits of clothing, should be sought and removed. The search for devitalized muscle and the necessary drainage of hematomata will usually lead one to them. On the other hand, an extensive search for high-velocity missiles, such as machine-gun and rifle bullets, is not justified. Such wounds rarely necessitate radical operation.

5. The neurovascular bundle should be carefully avoided.

6. The incisions should always be in the long axis of the limb.

7. In the forward area, since most of the injured will need to be evacuated, wounds should never be closed, but should be packed with gauze and the whole region immobilized in plaster. In the case of the femur, it may be that time and supplies will not allow the application of a spica. Opinion in the desert campaigns has been rather divided. In one command, it is observed that spicas have not been sufficiently comfortable for long transportation, and it is the custom, therefore, to use a firm supporting bandage for the thigh, reinforced by some plaster. Fixation is obtained by a Thomas splint and skeletal traction. The light plaster includes the lateral bars of the splint. In another command, spicas are used satisfactorily, and reports from the base comment on the comfort of the patients during transportation. In all cases of plaster immobilization the patient should be detained for at least twenty-four hours before being evacuated, and, if there is doubt about the circulation, the plaster should be split before he leaves.

CONTROVERSIAL POINTS IN CLOSED-PLASTER METHOD

There are certain controversial points concerning the closed-plaster treatment which it may be helpful to consider.

Extension

Trueta, in his writings, says very little about the problem of extension in compound fractures of the femur. The author discussed this point with him in England. He pointed out that with severe soft-tissue injury a good deal of muscle is sacrificed and tone in the remaining muscle is reduced. The problem is then quite different from a simple fracture of the femur in a healthy adult. It is generally agreed that fixation without extension cannot adequately maintain length in such cases. The author has had occasion to confirm the truth of Trueta's observations, as shown by the following case:

A patient with a severe thigh wound and compound fracture of the femur was admitted. Débridement was carried out and extension was maintained during the operation by a Kirschner wire through the tibial tubercle. A good deal of muscle was lost. The wound was packed and a supporting bandage was applied. The patient was then placed on a Thomas splint with traction of fifteen pounds maintained by the Kirschner wire. Roentgenographic examination the following day showed about one inch of separation. The traction was then reduced to eight pounds, but the separation persisted. The traction was finally removed but the ends did not come together. The ends of the bone were then pushed together, and the patient put in a plaster spica. The fragments ultimately united in good alignment. Although the wound was large, it remained clean, and the first plaster was not changed for ten weeks.

On the other hand, as Trueta pointed out and we have confirmed by experience, the closed-plaster treatment can be combined with extension wherever indicated, as in many compound fractures of the femur. In compound fractures of the tibia of an oblique or spiral type it is our practice to leave the Kirschner wire in place following the operation and to apply the plaster so that extension may be used if necessary when the patient is returned to the ward. In many of those cases in which the patients are ultimately transferred to a base hospital treatment is by skeletal traction. The wounds, however, continue to be treated by the closed method.

Type of Packing

We have found it an advantage to have the bottom layer of gauze at least treated with vaselin or some lubricant. An excellent material is that known as "jellonet", prepared originally for the moist-dressing treatment of burns of the face. A lining for the wounds is made with a layer or two of jellonet, and the main cavity is packed evenly with gauze. The packing should not be too tight, but should be applied snugly to the bottom of the wound. On the surface it should be flush with the skin. We have found that when plain gauze is used, and if a considerable period elapses before the plaster is changed, there is a tendency for the granulation to grow into the meshes, and it is removed only with some difficulty.

Fixation

We have continued to use skin-fitting plasters and have found them satisfactory and comfortable. Rarely has it been necessary to cut them. In one of our hospitals the pattern type of plaster slabs are used to some degree. They cut down time in the hands of those experienced in their use.

We have had, as yet, little experience in the use of the Roger Anderson pin fixation in the treatment of compound fractures. It would seem to be a procedure not generally suited to severe compound injuries demanding extensive skin incisions. Certainly its use is impractical in forward units. We have employed it to a limited degree in simple fractures, but the author is not convinced that it affords sufficient advantages over the more conservative means of fixation to warrant its adoption in every base hospital as a routine procedure.

Change of Plaster

In those cases where relatively early treatment has been undertaken, the original plaster may be left for from four to six weeks or longer. We have not found that the odor has been troublesome. In those cases where active infection is already present at the time of operation, the first change of plaster will probably be necessary in from two to three weeks. The black filter-cloth bags made of material supplied through the Medical Research Council are of value in controlling disagreeable odors. We have had to use them very little on our wards.

Skin Grafting

In cases where there has been extensive loss of skin we have employed skin-grafting in the later stages. This is seldom necessary in compound fractures. As a rule, the wound heals before the fracture.

Local Chemotherapy

As already indicated, we could find no evidence that wounds packed with sulphanilamide did better than those without it. This is also the experience of at least one other group of surgeons who are attempting to gather accurate information on this point for the Medical Research Council. In a recent communication from a New Zealand unit in the East, the officer in charge of a division of surgery concludes that wounds do better without local chemotherapy; he considers that local treatment delays healing. On the other hand, in those cases where active infection is already established before reaching the hospital, local and general chemotherapy have been used as an adjunct to surgery.

We have seen no instances of gas gangrene in wounds which have been treated primarily in our own hospitals by débridement and closed plaster. On the other hand, we have had three cases of extensive gangrene following primary treatment elsewhere.

Secondary Hemorrhage

In only one instance has secondary hemorrhage been encountered in relation to the closed-plaster treatment. This was a case of compound fracture of both bones of the leg. The patient was admitted to one of our hospitals some days after preliminary treatment in another center. The wound was already infected. It was further opened and packed, and the limb was immobilized. Subsequently it was noted that adequate drainage had not been provided, and evidences of hemorrhage were noted by the sister as fresh staining through the plaster. With removal of the plaster in the operating room a tremendous hemorrhage from the anterior tibial artery occurred. We felt that the firm pressure of dressing and plaster had adequately controlled the bleeding in the emergency, and thus allowed time to call the surgeon and get him to the theater.

CRUSH SYNDROME

We have encountered three cases of crush syndrome. An account of

one of them has already appeared in the literature. The pathology of this now fairly well-recognized condition has been described by Bywater and others. It is important to try to differentiate it from shock, with which it may be confused in the early stages. We, unfortunately, have had insufficient experience with the treatment by intravenous alkalies to judge its efficiency, but the rationale seems sound, and the author knows of no other effective type of therapy. Now that we are aware of the pathology, we look for earlier diagnosis and more success in treatment.

FAT EMBOLISM

Fat embolism has been observed much more frequently than in civilian practice. It may be due to the fact that most of our young surgeons are alert to the possibility of its presence as a complication in fractures. Any patient who, following a fracture, shows such symptoms as mild delirium and diffuse chest signs with increased respiratory rate, and particularly if he has petechiae over the upper chest and shoulders, should be investigated for fat in the urine and sputum. We are surprised at the number of cases which have been found, and also by the fact that in young soldiers it is not a very serious complication. The figures in one hospital show seven cases of fat embolism occurring in eighty cases of complicated fractures. Only one case was fatal. In another hospital one case out of six was fatal.

VASOSPASM

We have seen two serious cases of vasospasm in the lower extremity. The first one followed a bullet wound in the thigh, which traversed soft tissue and did not injure the artery or vein, but subsequent investigation showed a small hemorrhage in the sciatic nerve. This case went on to complete death of the muscles below the knee; they showed, on exploration, the characteristic appearance described by Griffith of Manchester, and the artery was in complete spasm. In spite of periarterial sympathectomy and other measures, an amputation above the knee was done. The other patient had a simple fracture of the tibia and fibula in the middle third. Little manipulation was required. Within twenty-four hours there was evidence of an extensive Volkmann's lesion, and exploration of the muscles showed the typical colorless appearance described by Griffith. In this case also an amputation above the knee was done. These two cases alone would provide a subject for prolonged discussion. The author wishes merely to call attention to this very serious condition. It is an alarming complication, and neither the etiology nor the treatment is sufficiently understood as yet.

FURTHER RESEARCH ON WOUND TREATMENT

We have recognized that careful observation and the keeping of records in special groups of cases must be the answer to the many unanswered problems of wound treatment. It is a fact, however, that just when there

is a rush of such cases the previous plans for such research are apt to become completely disorganized by bombing, the sudden moving of personnel, and the manifold exigencies of war. In the field, and there above all, careful effort should be made to record data. However, difficulties are greater, and too often patients, personnel, and records may all be lost. We in the Canadian Army feel that research along clinical and other lines should be made the responsibility of a special department under the directorship of a research worker, trained on very broad lines. He and his staff should coordinate attempts to solve the problems of war wounds, shock, and such others as are suggested from time to time. He should be free to plan the work, both in the base hospitals and the forward units, with access to such laboratories as are available.

CONCLUSIONS

In conclusion, there are certain main principles, of the soundness of which the author is convinced at the present time.

1. In mobile warfare it becomes a matter of the greatest importance either to evacuate the wounded by air or, failing this, to bring the facilities for early surgery to the patient.

2. The advantages of the closed-plaster treatment are paramount. It allows for safe transportation over long distances without the necessity for dressing during the journey. As already noted in reports from the East, "those who have been subjected to débridement and plaster fixation traveled well and looked fit on arrival". Furthermore, continued closed-plaster treatment at the base hospital would seem to be the method of choice. Our experience in Canadian hospitals after eighteen months encourages us to adopt the method as routine treatment.

3. It is clear from our experience in England, also from reports in Libya, that war wounds should not be sutured.

4. The use of sulphanilamide as a prophylactic measure is not on sufficiently firm ground to warrant the impression which is held by some surgeons that it will constantly prevent gas gangrene and other infection if applied to a contaminated wound. The author knows of no prophylactic against gas-forming organisms other than the early removal of devitalized muscle. When such débridement has been carried out and local chemotherapy used, we have been unable to see evidence of increased healing or lessening of infection when compared with those cases in which similar surgical treatment without chemotherapy has been instituted. On the other hand, sulphonamides given by mouth as soon as possible after injury may cut down the incidence of severe streptococcus infection, particularly when such cases are delayed in reaching an organized operating center. The application of sulphonamides to superficial wounds, particularly burns, is of undoubted value, but such routine use on the deeper penetrating wounds does not lessen the urgency for surgical treatment.

PRIMARY GENETIC DYSPLASIA OF THE HIP WITH AND WITHOUT CLASSICAL DISLOCATION *

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Classical congenital dislocation of the hip is secondary to a primary genetic dysplasia of the hip, or flat acetabulum, and develops during intra-uterine life, or in the course of the first or second year of postnatal life. Dislocation is a consequence of the primary dysplasia or "flat socket"; it is a secondary and incidental phenomenon. "Dysplastic acetabulum" is a term now generally accepted, and means a congenital and genetic anomaly of the acetabulum, with hip-joint instability and incongruity. The primary anomaly is not limited to the acetabulum, but involves all mesodermal structures of the hip joint. Aplasia or hypoplasia of the roof or buttress or posterosuperior portion of the rim of the acetabulum causes a flat socket which is the important expression of the dysplasia of the pelvis and hip joint. Dislocation of the femoral head may result because the hypoplastic and insufficient roof of the acetabulum lies in the axis of transference of forces of body weight and muscle contraction. Acclivity of the roof of the socket is the principal anatomical feature and a constant defect in congenital dislocation of the hip (Fig. 1).

Actual dislocation can, but need not necessarily, occur. Primary dysplasia of the hip without dislocation, but with varying degrees of subluxation, is a distinct clinical and roentgenographic entity, and is the one to receive consideration in this paper. The two entities, with and without dislocation, are identical in their etiology, but are different in their clinical and roentgenographic manifestations. Either entity may exist as a unilateral or bilateral lesion of the hip joint; frequently the two entities are present in a single patient with bilateral hip-joint dysplasia (Fig. 2).

Hip dysplasia with potential dislocation in a child one or several months of age may, if not properly treated, become a complete dislocation before or soon after the child starts to walk. Dysplasia of the hip with dislocation was at some previous period a potential dislocation; but hip dysplasia without dislocation does not necessarily progress to a complete or classical dislocation. Whether or not a gradual transition occurs from potential to complete dislocation depends on the degree of hypoplasia of the acetabular rim, the sex, the position *in utero*, and the forces of muscle contraction and weight-bearing. It is now an established fact

* This paper is based upon material presented in scientific exhibits at the Ninth and Tenth Annual Meetings of The American Academy of Orthopaedic Surgeons, held in New Orleans, Louisiana, January 1941, and Atlantic City, New Jersey, January 1942.

FIG. 1

Roentgenogram of patient twenty years after manipulative reduction of congenital dislocation of the left hip. Note that the principal anatomical feature and constant defect in congenital hip is acclivity of the roof of the acetabulum. The patient is now twenty-five years old. There is no evidence of traumatic arthritis which is inevitable at a later age. Secondary roentgenographic features of maldevelopment of the femoral head and neck are apparent, also the adaptive physiological sclerosis of the roof of the inadequate acetabulum.

that dysplasia of the hip with subluxation, which was thought to be only a precursor of the classical dislocation, may remain as a permanent deformity with characteristic clinical symptoms and roentgenographic findings.

In the textbooks, the chapter on congenital dislocation of the hip is incomplete, since only the entity "dysplasia with dislocation" is considered. The entity "dysplasia without dislocation", which is more common, and frequently more disabling than the classical dislocation, should be included. The terms "dysplastic acetabulum" or "hip dysplasia without dislocation", "preluxation", "potential dislocation", "inadequate acetabulum", "incompetent acetabulum", "fat socket", and "subluxation" are synonymous, since they are expressions for a single entity. The textbooks should include a chapter entitled "Dysplasia of the Hip". Two entities should be considered in this chapter: (1) "dysplasia with dislocation", and (2) "dysplasia without dislocation". Putti stated that subluxation is rather more common than dislocation, and that, while the latter can be easily diagnosed and therefore may be treated, the subluxation does not usually become evident until late in life, when every chance of cure is gone.

FIG. 2

Patient has always been disabled with a unilateral hip dislocation. She is now forty-six years old, and has experienced pain and stiffness during the past year in the opposite "normal" hip. Note the characteristic signs of primary hip dysplasia of the "normal" hip with early traumatic osteo-arthritis. Careful study of dysplastic acetabula shows that bilateral cases outweigh the unilateral, which is the opposite of statements made by earlier authors.

HEREDITARY CONDITIONS

Many authors have reported genetic occurrence in families in about 20 per cent. of all cases of congenital hip dislocation. It has been recognized since the first report by Ambroise Paré that the hereditary factor is of real importance. A notable and fundamental contribution to our knowledge of congenital dislocation of the hip was reported by Faber in 1937. Previous to Faber's work, all genetic investigations were based on the concept of a "dislocation gene" or diseased chromosome. The only "patients" in the genealogical studies were those with classical dislocation. Faber's research was based on the concept that the heredity, upon which dislocation of the hip depends, is not itself the hip dislocation, but, instead, is a primarily existent defect or acetabular anomaly which is in general designated as a flat socket. Because of a flat socket, an actual dislocation of the joint can, but need not necessarily, occur. There is no "dislocation-gene-conditioned chromosome", but there is a "hip-dysplasia gene". The hereditary factor is not the dislocation, but is a primary hip and acetabular dysplasia. Congenital hip dysplasia with and without dislocation are clinical expressions of the same gene-conditioned chromosome. They have the same heredity.

Roentgenographic consanguinity investigations were made by Faber

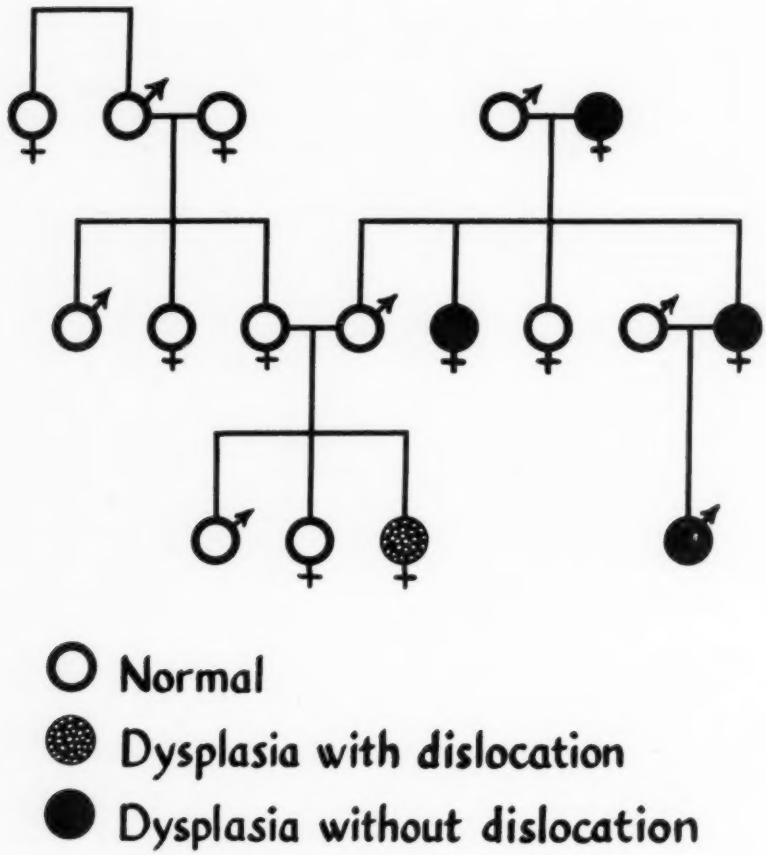

FIG. 3

One of Faber's roentgenographic consanguinity studies shows that in the family of the mother of the patient no carriers were found, while in the family of the father four carriers of the primary hip dysplasia without dislocation were found. (*Reproduced from Stammtafel 8. Zeitschrift für Orthopädie, LXVI, 160, 1937.*[2])

on all living members of the families of ten children with congenital dislocation of the hip (Fig. 3). The ten children were considered ostensibly sound in their heredity by those who accepted the concept of a "dislocation gene". From these studies, Faber demonstrated that dysplasia of the hip joint without dislocation was three times as frequent as was classical hip dislocation. In a total of ninety-eight cases of primary hip dysplasia, twenty-five were with dislocation and seventy-three without dislocation. The occurrence of primary acetabular dysplasia is, therefore, four times as frequent as had been supposed up to the present time, from the sole consideration of hip dislocation. In some of the families, only a few individuals manifested classical dislocation, while many showed hip dysplasia without dislocation. In one family, no dislocation was observed although many flat sockets were demonstrated. Not all apparently normal individuals were genetically sound. Some patients with

hip dislocation had parents who were normal in (phenotype) appearance, but roentgenographic studies showed one of the parents to have a flat socket. The affected parent, although clinically normal, was a latent carrier of the gene.

Variations in the manifestation or expressivity of the gene indicate that other conditions are active in determining the penetrance of the gene, and thus the expression of the character. Under the influence of function, a growing child with hip dysplasia without dislocation may in adolescent or adult life present a spontaneously healed or normal hip joint; the apparently normal individual would be genetically abnormal and a conductor or latent carrier of the "hip-dysplasia" gene. In many instances, it is not possible to measure the exact environmental condition which can affect the gene action. Genes primarily active in the development of a trait may act differently under various genotypes (genic milieu). A trait develops as the result of the interaction of several gene pairs; and, if one of these pairs is different, the primary gene may not be able to produce a trait as completely or as incompletely as it could under the other genic complex. Some genes are secondary in their nature of action, in that they modify the action of the gene pair primarily associated with the trait. A true genetic history cannot be gained from a study limited to classical dislocation, since this expression of the gene occurs only if the environment, genic and otherwise, is proper for that complete expression. Only by roentgenographic consanguinity studies can a true genetic picture with all the variations of the penetrance and expressivity of the gene-conditioned chromosome be gained.

The sex ratio of the total number of dysplasias approached the universal average, showing that there is, after all, not such a very great difference in the dysplasias of the hip joint between the sexes. The sex ratio of the total number of dysplasias with dislocation, however, revealed a preponderance of dislocations among the female sex. The ratio between the sexes did not vary from previously reported investigations on great numbers of cases, which revealed a ratio of female to male, of six to one. In the female, the dysplastic hip can lead much more easily to complete dislocation than in the male. This constant sex distribution is understood if it is true that a sex-conditioned structure of the pelvis exists,—the female having a more perpendicular innominate bone and a shallower acetabulum. The phenomenon of female-sex predominance with actual dislocation requires further investigation.

Sex linkage in the hereditary pattern does not exist, because the genealogical trees show transmission of the genetic character of hip dysplasia from father to son. The dysplasia gene is transmitted usually only from one of the parents, and a recessivity of the genes predisposing to primary dysplasia of the hip is not probable. Hip dysplasia is due to a dominant gene.

Mendelian ratios cannot be predicted in human families because the genotypes are not known at the time of mating, and the offspring

do not occur in numbers great enough to fulfill the mathematical expectancy.

PRIMARY ROENTGENOGRAPHIC FEATURES

There is no one particular roentgenographic form of hip joint to be exclusively designated as the normal. There is a range of normals, since there are numerous variations which certainly do not fall outside the classification of the normal. A range of normalcy so generous and wide will be recognized in order to eliminate error which

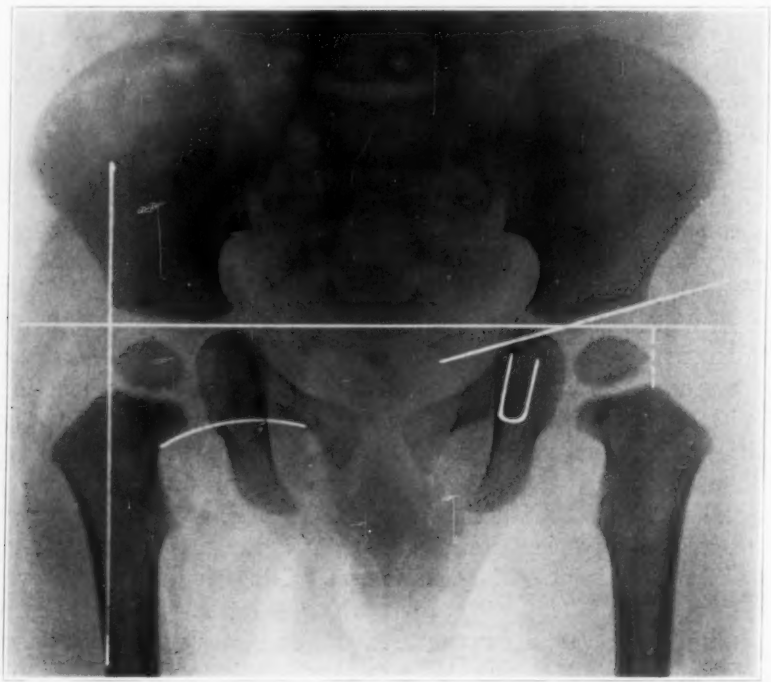

FIG. 4

Roentgenographic study of a normal hip (aged two years). A horizontal line is drawn on the roentgenogram through the clear areas in the depth of the acetabula, which represent the triradiate or Y cartilages. This line is called the Y line. A second vertical line is drawn through the lateral border of the acetabulum and the Y line. Normally the capital epiphysis lies below the horizontal line and within the lower medial quadrant formed by the Y and vertical lines. The angle of incidence of the roof of a normal acetabulum is about 20 degrees. This angle is formed by the junction of the Y line with a line passing from the depth of the socket at the Y line through the lateral border of the acetabular roof.

In case of unilateral hip-joint dysplasia, the vertical line is drawn on the normal side; and on the opposite side a parallel line is drawn at an equal distance from the mid-line.

In hip dysplasia without dislocation, but with varying degrees of subluxation, the capital epiphysis lies below or partially above the horizontal or Y line, but lateral to the vertical line. In hip dysplasia with actual dislocation, it lies above the Y line and lateral to the vertical line.

Note Shenton's line and the tear-drop. Also note the line which measures the distance from the most proximal shadow of the diaphysis to the Y line.

would necessarily result from a narrow and rigid definition of the normal.

The following description of the anatomical and roentgenographic appearance of the normal hip is quoted from Wiberg:

"The acetabulum of the hip joint is a hollow which embraces 170 to 175 degrees of a sphere, and whose opening looks forwards, outwards and downwards. Lining the circumference of the hollow and enclosing the acetabular fossa is the lunate surface, a horseshoe-shaped surface with an anterior and posterior horn which articulates with the head of the femur. Articular cartilage is only found on the lunate surface. The acetabular fossa is filled by the ligamentum teres and fat tissue, and continues in front and below into the obturator foramen by means of the acetabular notch (incisura acetabuli). Attached to the bony margin of the acetabulum and increasing the depth of its cavity is the cotyloid ligament, otherwise known as the labrum glenoidale or limbus of the hip joint. Its inner surface, which is concave, constitutes a direct continuation of the articular cartilage in the acetabulum; its outer surface is convex. The capsule is attached superiorly to the bony margin of the acetabulum outside the attachment of the cotyloid ligament, and consequently there is a space between the two. At the acetabular notch, the cotyloid ligament continues into the transverse ligament.

"The femoral head forms about two-thirds of a sphere and is practically spherical in shape. Two-thirds to three-quarters of the head are received into the acetabulum and cotyloid ligament.

"The roentgen picture of an adult hip has a number of characteristic features [Fig. 6]. As a rule, the acetabulum appears as a practically circular segment. The upper part, the roof, runs practically horizontally, with the vertex of the concavity lying almost directly above the center of the head. The inferior part of the acetabulum, the floor, lies practically vertically, and corresponds anatomically with the acetabular fossa. The transition between these two parts of the joint cavity is marked by a step. At the same time the bottom of the acetabular fossa, the acetabular floor, gives rise to the outer side of the formation which is called the U figure, or the tear figure, whose inner side is formed by the bony border of the small pelvis. That this is the way the U figure is formed has been proved by Werndorff, who made it disappear in the roentgen picture by sawing out the bottom plate of the acetabular floor.

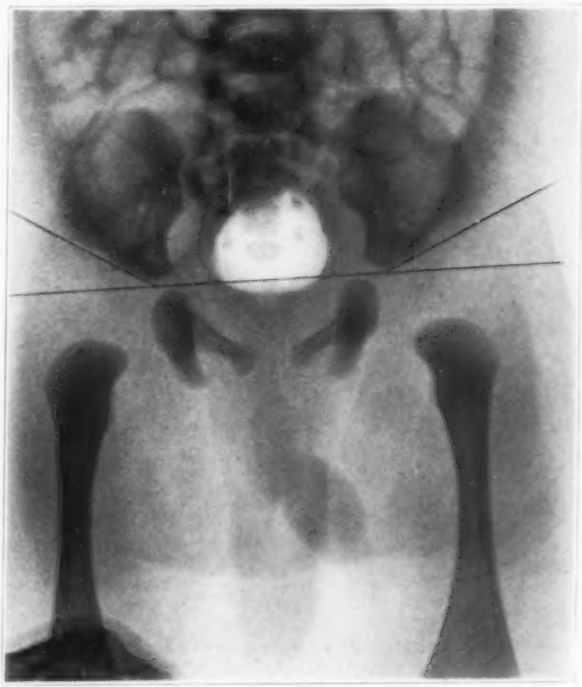

FIG. 5

Roentgenogram of a normal newborn (aged one day). Note the acetabular index.

"The bone in the acetabular roof nearest

the articular cartilage is comprised of a thin layer of cortex which appears as a dense zone in the roentgen picture . . . [Fig. 6].

"If the line of the inner curve of the neck is extended, it will continue along the upper border of the obturator foramen—Shenton's line [Fig. 4].

"Children show a number of characteristic details in the roentgen picture, due to the incomplete ossification of their joints [Fig. 4]. The cartilage connecting the three pelvic bones in the acetabulum appears as a gap, and because this cartilage has the shape of a Y anatomically, it is called the Y [or triradiate] cartilage . . . therefore . . . the line which is drawn through both the gaps [is known as] the Y line. If the cartilaginous area is broad, it may be difficult to know where to draw the Y line. . . . The bony part belonging to the ischium [is selected] as a definite point, and the line [is drawn] so that it touches it. As long as the epiphyseal nucleus is still separated from the rest of the neck by an epiphyseal line, the most medial part of the diaphysis of the neck looks like a spine, and is called the spine of the neck."

Proper roentgenographic technique is essential to prevent distorted views and erroneous measurements. The patient must be relaxed and placed flat on his or her back. The lower extremities should be in contact, the hips extended, and the patellae facing directly forward. The roentgen tube must be centered in the mid-line of the body and directly over the superior border of the symphysis pubis.

Roentgenographic diagnosis of hip dysplasia without dislocation is

FIG. 6

Note the characteristic features of primary dysplastic acetabulum (Calot's half-citron socket). There is physiological adaptive sclerosis of the acetabular roof. The patient's complaints were hip fatigue and a mild limp when tired. Symptoms were completely relieved by rest and change of occupation. The opposite hip is normal. The patient is a female in the period of early adult life. Her sister is disabled with a classical hip dislocation.

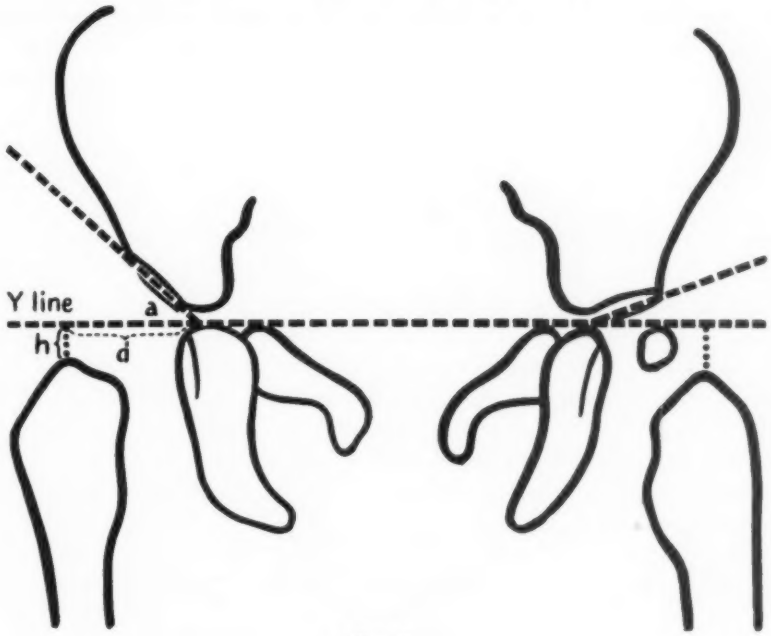

FIG. 7

Hilgenreiner's measurement. Note the Y line, acetabular index (*a*), high position of the diaphysis as measured from the most proximal shadow of the diaphysis to the Y or triradiate line (*h*), increased distance from the most proximal shadow of the diaphysis to the acetabular floor (*d*). (*Reproduced with slight changes from Abbildung 1. Zeitschrift für Orthopädie, LXVI, 151, 1937.*[2])

very difficult during the first months of life, and the condition is rarely recognized except where the routine examinations of the newborn are made. Most often it is dislocation of the opposite hip which leads to its discovery. Putti recognized and treated by his abduction method a dysplastic hip without dislocation in a child only thirty-four days old. Unless dislocation is present on the opposite side, it is advisable to wait until the third or fourth month before reaching a definite conclusion; then the ossification center of the femoral head is visible in the roentgenogram and the possibility of error is reduced.

Hip dysplasia or "flat socket" refers not only to the steep acetabulum, but also to all joint-forming parts of the hip joint. However, the primary anatomical and roentgenographic feature of hip dysplasia is the abnormal acclivity of the roof of the acetabulum, which increases the angle of incidence of the roof of the socket. The acetabular index is the angle formed between the roof or iliac portion of the acetabulum and a horizontal line passing through the Y or triradiate cartilages (Fig. 4). Normally the acetabular index in a child is about 20 degrees. The angle is increased to 30 or more degrees in dysplasias (Fig. 7). Kleinberg and Lieberman studied the angle of incidence of the roof of the acetabulum and found the average angle of incidence in the normal newborn to be

27.5 degrees (Fig. 5), and at two years of age 20 degrees (Fig. 4). The angle was 37.5 degrees at the age of two years when the hip presented dysplasia with dislocation. The authors stated that if the angle of incidence is above 30 degrees in an infant, a dislocation probably will develop. The flatness of the inadequate and incompetent acetabulum can further be proved through the increase in the radius of curvature where the centrum of the sector, which the acetabulum presents on the roentgenogram, goes off laterally, instead of, as in the normal, lying somewhere in the middle of the head of the femur (Calot's half-citron shape). (See Figure 6.)

Besides all degrees of subluxation of the femoral head, from the imperceptible to the extreme or potential dislocation, the following features, which are an integral part of the primary dysplasia, should be noted:

1. Hypoplasia of the pelvis.
2. Hypoplasia of the head and central diaphyseal end of the femur (observed before puberty).
3. Delayed appearance and hypoplasia of the epiphyseal ossification center of the head of the femur.

FIG. 8

Note the characteristic features of hip dysplasia with added secondary changes of traumatic arthritis, manifested by loss of joint space, sclerosis, cystic areas of rarefaction, double acetabular floor, osteophytic deposits, and capital drop. The patient is now sixty years of age and walks with the aid of a crutch. Her mother was disabled with classical hip dislocation.

4. Disturbance of Shenton's (obturator-coxofemoral) line.

5. Delayed bony bridging of the ischiopubic synchondrosis.

6. Increased distance of the most superior shadow of the metaphysis or neck of the femur from the acetabular floor or tear-drop shadow (if it is present).

7. High position of the diaphysis as measured from the most proximal shadow of the diaphysis to the Y or triradiate line.

8. The increase in the distance from the shadow of the most medial part of the metaphysis of the neck, which looks like a spine and is called the spine of the neck, to the acetabular floor, or tear-drop, and the decrease in the distance to the Y line.

9. Frequently a classical dislocation of the opposite hip.

10. The position of the limbus cartilage and the relation of the cartilaginous acetabulum to the femoral head as shown by arthrography.

Putti, one of the greatest authorities on hip dysplasia without dislocation, or preluxation as he called it, depended on the following triad for diagnosis (Fig. 7):

FIG. 9

Note the characteristic features of primary hip dysplasia with acclivity of the acetabular roof and subluxation. Secondary changes of traumatic arthritis with loss of joint space, sclerosis, cystic rarefaction, and double acetabular floor have been added to the primary features. The patient's onset of symptoms had occurred six years previously, with hip fatigue and limp. One year previously severe pain, loss of motion, and deformity developed. She was totally disabled for work, and was not relieved by conservative measures. The opposite hip presents a very mild expression of dysplastic acetabulum. She has a sister disabled with bilateral hip dysplasia, with dislocations reduced in 1903 by Dr. Adolf Lorenz. (See Figure 10.) Arthrodesis of the hip was advised and performed.

1. An increased distance between the upper femoral diaphysis and the acetabular floor.

2. Hypoplasia or delayed development of the epiphyseal nucleus of the femoral head.

3. An abnormally steep or short acetabular roof.

Functional instability and anatomical incongruity are the important expressions of congenital dysplasia of the hip, and can be identified by:

1. Hilgenreiner's measurements (child). (See Figure 7.)
2. Calot's half-citron-shaped acetabulum (Fig. 6).
3. Wiberg's pattern (adult).

SECONDARY ROENTGENOGRAPHIC FEATURES

Because of the repeated trauma resulting from abnormal sheering forces, mechanical instability, and incongruity of the dysplastic hip, secondary changes are added to the primary anatomical and roentgenographic features. These changes may be listed as follows:

1. Increased subluxation when compared with previous studies.
2. Delayed development of the epiphyses.
3. Delayed fusion of the epiphyses.
4. Maldevelopment of the femoral head and neck (Wolff's law).
5. Increased sclerosis of the acetabular roof. The degree of sclerosis is in direct proportion to the degree of maldevelopment of the acetabular roof,—physiological adaptive sclerosis (Fig. 6).
6. Coxa valga luxans (Klapp).
7. Osteochondrosis, coxa plana, Legg-Perthes disease, or osteochondritis deformans coxae juvenilis.
8. Traumatic hypertrophic arthritis of the hip joint or malum coxae senilis with: (a) narrowing of the joint space; (b) osteophytic deposits, capital drop, and double acetabular floor; (c) sclerosis of bone and areas of cystic rarefaction involving the weight-bearing areas of the acetabulum and femoral head (Fig. 8).

The author is aware of the fact that coxa plana or Legg-Perthes disease does not necessarily have a dysplastic acetabular background. He has observed several cases of coxa plana develop in clinically and roentgenographically normal hips. The acetabular changes were adaptive and developed secondarily to the deformed head. However, the author believes that primary dysplasia of the acetabulum may be the precursor of a group of cases with clinical findings and roentgenographic features that are indistinguishable from cases of coxa plana of unknown etiology. This problem should stimulate investigation.

Preiser in 1907 presented his theory that development of osteo-arthritis in the hip was due to poor adaptation between the head and the joint cavity. Wiberg in 1939 conclusively demonstrated the correctness of Preiser's theory. He presented roentgenographic studies of nineteen cases with primary hip dysplasia before and after the development of secondary changes of osteo-arthritis.

The author believes that osteo-arthritis of the hip, or malum coxae senilis, is frequently traumatic arthritis and develops because of anatomical incongruity and instability of a primary dysplastic acetabulum. He has studied sixteen patients who had disability from dysplastic acetabula. Each patient had one member of the family disabled with classical congenital dislocation of the hip. The author's first case (Fig. 9) was recognized in 1935. The patient's sister had congenital dislocation of both hips (Fig. 10), which were reduced by Dr. Adolf Lorenz in Chicago in 1903. This patient with hip dysplasia without dislocation, but with secondary traumatic arthritis, was being treated for tuberculosis of the affected hip.

ROENTGENOGRAPHIC DIFFERENTIAL DIAGNOSIS

The following list of hip-joint lesions may at times require careful study for differentiation from primary hip dysplasias:

1. Coxa plana or Legg-Perthes disease,
2. Epiphyseal separation,
3. Tuberculosis,
4. Infectious arthritis,
5. Hypertrophic arthritis,
6. Aseptic necrosis,

FIG. 10

The patient had bilateral hip dysplasia with dislocations which were reduced by Dr. Adolf Lorenz in 1903 when the patient was three years of age. Note the signs of bilateral hip dysplasia with added changes of traumatic arthritis. The patient is now seriously disabled at the age of forty-two years. Her sister has hip dysplasia without dislocation, but with secondary changes of traumatic arthritis. (See Figure 9.)

7. Late septic hip,
8. Neoplasm,
9. Neurotrophic lesions,
10. Old fracture-dislocations,
11. Endocrine dysfunction.

CLINICAL FINDINGS

Clinical manifestations of dysplasia of the hip without dislocation depend upon the degree of incongruity, subluxation, acetabular instability, age, occupation, weight, activity, and general health of the individual; and also upon whether or not the opposite hip is dysplastic, with or without dislocation.

If classical dislocation does not occur soon after birth, then there are essentially two possibilities:

1. The acetabulum returns to normal under the influence of function, with or without abduction treatment. The individual with a spontaneously healed dysplastic acetabulum will present no abnormal clinical findings or roentgenographic features in later life. The dysplastic hip with classical dislocation may return to normal after treatment, but the percentage which actually does return to normal roentgenographically must be very small.

2. The dysplastic hip without dislocation remains flat with incongruity and instability. Some of the patients in this group with mild maldevelopment of the acetabulum may at no time during life present any subjective or objective clinical findings. The hip dysplasia may never be recognized because it is asymptomatic. Roentgenographic study would be the only means of its recognition. Other patients in this group with slight subluxation are free from subjective or objective clinical findings during infancy, childhood, and adolescent life. During the period of early adult life the patient may complain, not of pain, but of a feeling of hip fatigue and a slight limp, especially when physically tired from work, unusual exercise, or sport (Fig. 6). Symptoms subside with rest, but recur weeks or months later. Clinical examination may be normal except for slight atrophy of the affected extremity. Roentgenographic study at this period demonstrates the features of the primary dysplastic hip, without secondary changes except for adaptive physiological sclerosis of the subchondral weight-bearing portion of the acetabular roof (Fig. 6). Symptoms of pain, fatigue, and limp increase with the years. Disability increases, and the periods of pain and limp are more difficult to relieve with rest. Osteo-arthritis gradually develops as a result of local frequently repeated microtrauma. Traumatic arthritis adds to the subjective and objective clinical findings. Stiffness, morning pain, limited motions, and deformity develop. The extremity often presents an adduction, flexion, and external rotation deformity, with apparent and real shortening. In middle or late adult life, the patient may be totally disabled for work (Fig. 9). Frequently the patient

has been treated for foci of infection, tuberculosis, sciatica, osteochondritis, and infectious arthritis; and has been deprived neither of the many "shots" and minor operations for removal of foci of infection, nor relieved of the mental and economic strain which are inevitable when searching for etiological factors over a period of years. It is very important to recognize the mechanical factors of painful dysplastic hips.

Symptoms may appear during childhood, and it may be extremely difficult to differentiate the lesion from Legg-Perthes disease unless a genetic study is made. Symptoms may not begin until adolescent life.

The lesion may be found accidentally if the opposite hip is being studied roentgenographically for dislocation. There is no doubt that bilateral hip dysplasia will be recognized more and more, due to the fact that more thorough examination of the "healthy" side will prove that it too is not normal. Not infrequently a patient, who has been disabled over a period of many years because of unilateral dislocation, will experience pain and stiffness of the "normal" hip. Roentgenographic study will reveal that the "normal" hip is actually a dysplastic hip without dislocation, but with secondary changes of traumatic osteoarthritis (Fig. 2).

It is true that the clinical onset and the severity of the disability are inconstant, but there seems to be some correspondence between the degree of dysplasia and the onset of symptoms. There is also some

FIG. 11

Roentgenogram of patient thirty-five years old. Note the primary and secondary roentgenographic features of bilateral hip-joint dysplasia without dislocation. The patient's brother has classical dislocation of both hips.

relationship between the extent of osteo-arthritis and the severity of clinical disability. This is not constant, however, since there are the factors of obesity, type of occupation, activity in sports, and general health which influence the onset of symptoms and the severity of the disability.

MICROSCOPIC PATHOLOGY

Microscopic pathological changes observed in the dysplastic hip with secondary traumatic osteo-arthritis were described by Sawyer and Ghormley in 1941. The author's material for study has been limited, but his findings correspond to the changes noted by Sawyer and Ghormley, who reported:

"1. The initial degenerative changes appear in the cartilage and are characterized by fibrillation, pitting, degeneration of the cartilage cells, and increased calcification of the deeper matrix.

"2. The marginal cartilage proliferates and shows few of the signs characteristic of degeneration.

"3. As the cartilage disintegrates and is worn away, the bone is exposed and becomes eburnated with thickening of the subchondral plate and the subjacent trabeculae by means of intramembranous ossification.

"4. The subchondral plate may or may not be thickened. The trabeculae are almost never increased in size in those areas that are still protected by cartilage, and most formation of new bone in these areas is of the endochondral type.

"5. The normal marrow is replaced by fat or loose fibrous tissue which, in some instances, dedifferentiates into osteoid tissue.

"6. The synovial membrane is invaded by fibrous tissue with markedly increased vascularity.

"7. Little evidence was found to support the hypothesis that arteriosclerosis is an etiologic factor of osteo-arthritis.

"8. Finally, no collections of lymphocytes were found which are characteristic of the infectious types of arthritis."

TREATMENT

Dysplasia of the hip without dislocation, in the author's experience, presents no characteristic clinical signs in the infant. The anomalous hip is recognized during infancy through roentgenographic studies because of dislocation of the opposite hip or in a routine roentgenographic examination of hips as practised by Putti. If the condition is recognized in an infant, with complete dislocation of the opposite hip, then the hip without dislocation should be splinted in abduction during the period of immobilization of the reduced dislocated hip. A mildly dysplastic hip in an infant, recognized by routine roentgenographic studies of the hips, however, should not be treated until after the fourth or fifth months, when a more certain conclusion can be made. Since an error can be excluded by waiting and spontaneous healing is possible during this period, there is good reason for the postponement of treatment.

If a dysplastic hip is present after the fourth month in an infant or child, then treatment in an abduction splint for several months or more, as recommended by Putti, is expedient.

As previously stated, many of the dysplastic hips without dislocation

remain asymptomatic for many years. The patients with symptoms of fatigue, pain, and limp should be advised to spare the hip, and refrain from strenuous sports, jumping, and long hikes. A rest period during the middle of the day is beneficial. Obesity must be prevented. The patient's occupation should not require long periods of standing or walking. Lifting and carrying heavy objects should be discouraged. A moderate raise to the heel of the shoe of the opposite, normal extremity may help to relieve symptoms, since elevation of the pelvis on the normal side will improve stability of the dysplastic hip in the standing position. A crutch or cane is often necessary, and should be used on the normal side to aid the gluteal mechanism and enhance stability of the dysplastic hip. Physiotherapy, various forms of hip spicas, roentgenotherapy, manipulation, and traction are measures which may give temporary relief. Conservative measures should always be tried first. If they fail, then operation may be considered.

At this point, the causes of pain and disability should be restated, since the recognition of them is a prerequisite to any well-planned surgical procedure. The disability is caused by hip-joint instability and incongruity during the early years, and by the additional factor of traumatic arthritis during the later years (Fig. 11). A perfect shelf operation does correct instability and, therefore, improves the patient's condition, but it does not correct the serious factor of incongruity. Therefore, operation may fail if the patient does not continue to guard the hip against overstrain as suggested under the conservative program. Osteo-arthritis may develop subsequently as a result of the remaining hip-joint incongruity.

Arthrodesis of the hip, intra-articular and extra-articular, must be considered in single or unilateral hip lesions after the additional factor of traumatic arthritis has increased the pain and disability. Watson-Jones' nail-fixation, arthroplasty, and McMurray's osteotomy should also be included in the possible surgical methods to relieve pain and disability of the dysplastic acetabulum with traumatic hypertrophic arthritis.

SUMMARY

1. One human trait which has been difficult to explain genetically is congenital dislocation of the hip.

2. An individual does not inherit congenital dislocation of the hip, but does inherit a primary defect, or hip dysplasia, which produces anatomical and physiological alterations of the joint called "flat socket". Only secondarily does actual dislocation occur, and dislocation need not necessarily occur.

3. Primary hip dysplasia is due to a genetic background.

4. Roentgenographic consanguinity studies are essential for a true genetic investigation of hip dislocation.

5. There is no "dislocation" gene.

6. There is a "hip dysplasia" gene.

7. The gene involved is not a recessive gene, but is a dominant gene.

8. The trait of hip dysplasia cannot be sex linked, because it is observed to pass from father to son.

9. Dysplasia of the hip without dislocation is a distinct clinical and roentgenographic entity, and should be included in textbooks in the chapter on classical dislocation, because the two entities have the same genetic etiology.

10. Dysplasia of the hip without dislocation occurs more frequently and may be more disabling than classical dislocation.

11. Acclivity of the roof of the acetabulum is the primary anatomical feature of a dysplastic acetabulum or flat socket.

12. Hip dysplasia refers not only to the acetabulum, but also to all joint-forming parts of the hip joint.

13. Primary hip dysplasia can lead much more easily to complete dislocation in the female than in the male.

14. Primary hip dysplasia with dislocation on one side is frequently associated with dysplasia without dislocation on the opposite side.

15. Hip-joint instability and incongruity between the head and socket are the physiological and anatomical expressions of hip dysplasia without dislocation.

16. Primary hip dysplasia may remain asymptomatic for many years; in some individuals it may never be expressed clinically.

17. The extreme disability observed in some individuals is caused by traumatic arthritis of the hip joint resulting from mechanical factors of instability and incongruity.

18. The patient may gain relief of pain and disability by conservative treatment and surgical measures.

19. The geneticist and the surgeon have a tremendous opportunity for cooperative investigation.

The author wishes to acknowledge the valuable assistance he received from C. P. Oliver, Ph.D., geneticist, and Director of the Charles Fremont Dight Institute for the Promotion of Human Genetics, University of Minnesota. The encouragement given by his Commanding Officer, Col. Wilson C. von Kessler, and the Chief of the Surgical Service, Lt.-Col. Sumner Everingham, made possible the writing of this paper.

The writer has quoted freely from the authors whose works are included in the references.

REFERENCES

1. Calot, F.: Les récentes acquisitions sur la luxation congénitale de la hanche. Presse Méd., XXVIII, 666, 1920.
L'Orthopédie indispensable aux Praticiens. Ed. 9. Paris, N. Maloine, Éditeur, 1926.
2. Faber, Alexander: Erbbiologische Untersuchungen über die Anlage zur "angeborenen" Hüftverrenkung. Ztschr. f. Orthop., LXVI, 140, 1937.
3. Hilgenreiner, H.: Zur Frühdiagnose und Frühbehandlung der angeborenen Hüftgelenkverrenkung. Med. Klin., XXI, H. II, S. 1385 und 1425, 1925.
4. Klapp: Coxa valga und Luxatio coxae. Deutsche Med. Wchnschr., XXXII, H. II, S. 1884, 1906.

5. Kleinberg, Samuel, and Lieberman, H. S.: The Acetabular Index in Infants in Relation to Congenital Dislocation of the Hip. Arch. Surg., XXXII, 1049, 1936.
6. McMurray, T. P.: A Practice of Orthopædic Surgery. Baltimore, William Wood & Co., 1937.
7. Mercer, Walter: Orthopædic Surgery. Ed. 2. Baltimore, William Wood & Co., 1936.
8. Paré: *Quoted by* Alexander Faber[2].
9. Preiser, Georg: Die Coxa valga congenita—die Vorstufe der kongenitalen Hüftverrenkung. Ztschr. f. Orthop. Chir., XXI, 177, 1908.
Die Arthritis deformans coxae und die Variationen der Hüftpfannenstellung. Leipzig, F. C. W. Vogel, 1907.
10. Putti, Vittorio: Early Treatment of Congenital Dislocation of the Hip. J. Bone and Joint Surg., XI, 798, Oct. 1929.
11. Sawyer, M. H., and Ghormley, R. K.: Pathologic Study of Hypertrophic Arthritis of the Hip. Surg., IX, 381, 1941.
12. Watson-Jones, R.: Fractures and Other Bone and Joint Injuries. Ed. 2. Baltimore, Williams and Wilkins Co., 1941.
13. Wiberg, Gunnar: Studies on Dysplastic Acetabula and Congenital Subluxation of the Hip Joint. With Special Reference to the Complication of Osteo-Arthritis. Acta Chir. Scandinavica, LXXXIII (Supplementum 58), 1939.

REPAIR OF COMPLETE ACROMIOCLAVICULAR DISLOCATION, UTILIZING THE SHORT HEAD OF THE BICEPS *

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When there is an incomplete acromioclavicular dislocation,—that is, when only the acromioclavicular ligaments are ruptured—reduction can easily be carried out and maintained with non-operative procedures, such as immobilization in plaster for three weeks. In these cases, the clavicle generally stays in correct relationship with the acromion process of the scapula. If there is any dislocation, it is generally very slight. The majority of cases in everyday practice do not demand surgical measures.

When, however, there is complete dislocation with marked displacement, the conoid and trapezoid ligaments are most certainly ruptured; conservative procedures, under these circumstances, do not give satisfactory results. Surgical intervention is indicated to produce and maintain a stable joint with satisfactory function.

The purpose of this paper is to describe a surgical procedure for complete dislocation of the acromioclavicular joint. It was suggested in 1941 when a patient presented an unstable acromioclavicular joint following a complete dislocation, although three attempts had been made to produce a satisfactory joint by conservative measures. The author makes no claim for originality; in discussing the possibilities as to surgical repair with Dr. Mario Jorge de Carvalho, Head Surgeon of the Central Hospital for Wounded in Accidents (*Hospital Central de Accidentados*), he suggested the utilization of the short head of the biceps. It was decided to first perform this technique on a cadaver. Anatomical experiments proved that the short head of the biceps was easily available, and that it was sufficiently strong to withstand the required tension.

The technique of the procedure is as follows: A saber-cut incision is made over the anteromedial aspect of the shoulder, beginning two centimeters medial to the acromioclavicular joint and extending distally along the extremity for nine centimeters. The deltoid muscle is separated in the line of its fibers, visualizing the ruptured coracoclavicular ligaments. In fresh cases a hematoma will be present in this area. Upon exposure of the coracoid process, the short head of the biceps is split in half longitudinally for six centimeters, leaving its proximal end attached to the coracoid process. Distally, one-half of the tendon is incised transversely near the muscle fibers and this tendon slip is reflected proximally. A hole, eight millimeters wide, is then drilled in the clavicle immediately above the coracoid process. The new ligament is passed upward through this hole

* Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 6, 1942.

over the anterior edge of the clavicle and sutured to itself. A bone peg is driven into the hole to secure further fixation of the tendon.

After routine closure, the upper extremity is immobilized in a plaster-of-Paris cast, the arm being held against the chest for a period of twenty days.

CASE REPORT

M. H. T., a Brazilian, aged forty-nine, a stevedore, was examined on December 20, 1941. He had been injured one month previously when he fell from a ladder onto his outstretched right arm. There was immediate intense pain and impairment of function of the entire right upper extremity. Examination revealed complete upward and backward displacement of the outer extremity of the clavicle at the acromioclavicular joint,—the so-called Galen's dislocation. Obviously the acromioclavicular ligament and the conoid and trapezoid ligaments had been completely ruptured. Roentgenograms confirmed the clinical diagnosis.

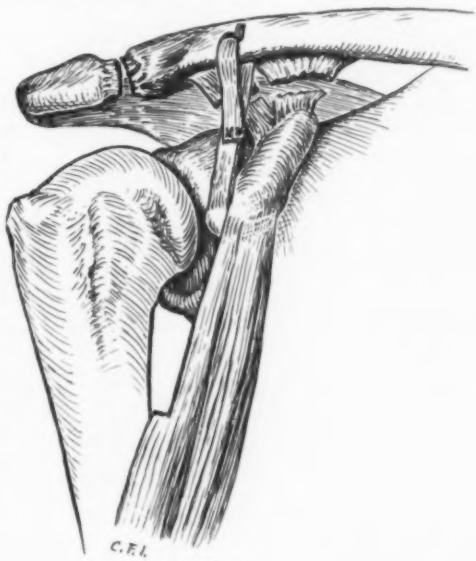

FIG. 1

Having undergone non-operative procedures with unsuccessful results, the patient requested surgical repair of the affected joint. On December 28, 1941 the technique described was carried out. Immobilization was discontinued in twenty days. This workman soon regained ample movements of the arm and was carrying on his activities as a stevedore six weeks after operation.

Roentgenograms on January 5, 1942, still showed some separation of the acromioclavicular joint. Despite this slight displacement, the patient is able to carry on his normal occupation as a stevedore, certainly a very strenuous one, without impairment of the use of his arm.

SPASTIC SCOLIOSIS AND OBLIQUITY OF THE PELVIS

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From the Shriners' Hospital for Crippled Children, San Francisco

Scoliosis of the spine with pelvic obliquity, due to spastic paralysis, is an infrequent clinical entity. The correction of this deformity is difficult because of the complicated causative mechanical factors, the disorganization of normal muscle control, incoordination, and disturbance in equilibration. It is important that, in attempting a correction of this deformity, one does not further disrupt locomotion by increasing the imbalance or enhance the ability of accommodation for coexisting deformities.

In the treatment of spastic contracture in general, a number of opera-

FIG. 1-A

FIG. 1-B

Patient standing before operation.

tive procedures are utilized,—lengthening of tendons, neurectomies, transference of overacting muscles, and stabilization of joints. With a deformity involving the trunk and pelvis, it is obvious that the problem is more complicated because the entire circumference of the chest and pelvis must be held in balance by a number of muscles and an erect spine.

The specific problems of treatment may be better appreciated after the presentation of the history and findings of a patient with this deformity.

F. T., male, was thirteen years of age when first seen by the author. The family history was negative. Three other children were living and well. No similar trouble or neurological disturbance had occurred in any other member. From the history the birth had been a difficult breech presentation followed by cyanosis, but no convulsions. He had had bronchial pneumonia and measles. His development had been slow, and at ten months he had been unable to sit up. He had been able to walk a little at the age of three years. When he was first examined at the Shriners' Hospital in St. Louis on January 4, 1929, he had been able to walk a little. There was at that time a marked spasticity of the right arm and leg. During the years 1931 and 1939, adductor tenotomies and neurectomies of the anterior branches of the obturator nerves were performed. The biceps femoris and semitendinosus were transferred to the patella, and the insertion of the patellar ligament was placed medially on the tibia. He was then given long leg braces. The patient was admitted to the Shriners' Hospital in San Francisco on January 25, 1940, at the age of thirteen years.

FIG. 2

January 29, 1940. Roentgenogram taken before operation showing scoliosis of the spine and obliquity of the pelvis.

On examination it was found that he was able to walk with considerable difficulty with long leg braces, but used crutches the greater part of the time. He did not present a very favorable impression at first, and this was further impaired by a considerable impediment of speech. However, it was found that, in spite of his many handicaps, his intelligence was of average degree, and he showed definite ability to cooperate and a desire to improve his condition. There was a moderate spasticity and contracture of the flexors and internal rotators of the right hip joint and of the adductors.

On standing, there was a scoliosis of the lumbar spine with convexity to the left, and

an associated obliquity of the pelvis, which was high on the right and low on the left side. The knees were held in flexion, the left more than the right, to accommodate for the pelvic shift. The left foot was in a marked valgus position and there was considerable instability in the right foot. The photographs (Figs. 1-A and 1-B) show the patient standing. The roentgenogram (Fig. 2) shows the scoliosis of the spine and the obliquity of the pelvis.

On February 12, 1940, the flexion and internal rotation contractures were treated by a combined Soutter and Durham release of the flexors and internal rotators of the hip joint. The tight abductors were severed by an open tenotomy.

A Kirschner wire was inserted through the upper end of the crest of the tibia, and both lower extremities were encased in plaster from the toes to the groin. A Carl Jones splint was applied, and, after healing was complete, the pelvic obliquity and scoliosis could be corrected by pushing up on the left side and pulling down on the right. After the apparatus was released the deformity returned to the original proportions.

The problem that presented itself was to maintain the correction of the deformity. The following methods were given consideration before a decision was reached:

1. Fusion of the spine. This would have to include the sacrum with the lumbosacral joints, and all the lumbar vertebrae. In view of the bad results obtained with this type of fusion in cases of poliomyelitis, it was thought to be particularly inadvisable in spastic paralysis. A constant strong unilateral pull may cause a return of the deformity with permanent fixation. A spastic patient with disturbance in equilibration may need the free movement of the spine and pelvis to maintain his balance.

2. A strut graft from the ilium to the rib cage on the side of flexion, in conjunction with fusion or other procedures, would have the same limitations as spine fusion,—too much fixation and difficulty of maintaining the correction if the operation was successful.

3. The release of the spastic sacrospinales, lateral and anterior abdominals, and quadratus lumborum would entail an extensive dissection, a difficult problem of balance of pull, and the possibility of herniation and other bad sequellae.

4. Neurectomies or other nerve-destroying operations to the involved muscles were not considered advisable because of the possibilities of the last method.

5. Fascial slings or checks from the ribs to the pelvis on the opposite side, as have been used in poliomyelitis, may be successful. The opposing strong constant pull would tend to stretch the fascia unless a compensatory hypertrophy of the fascia took place. There was also the difficulty of completely fixing one half of the pelvis.

6. The greater pull of the spastic muscles on the right side over the normal muscle pull of the muscles of the left side was considered to be responsible for the scoliosis and the obliquity of the pelvis. If some of the pull of the anterior and posterior muscles could be transferred to the opposite side and the correct balance obtained, the deformity could be permanently corrected. As the deformity could be actively corrected by the use of the Carl Jones splint, it was known that no permanent structural changes had taken place. If the method did not work, then some of the

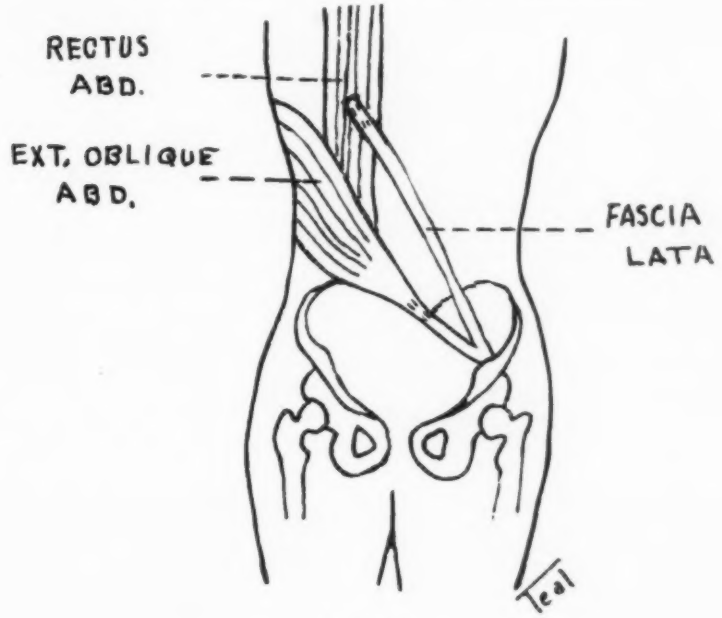

FIG. 3-A

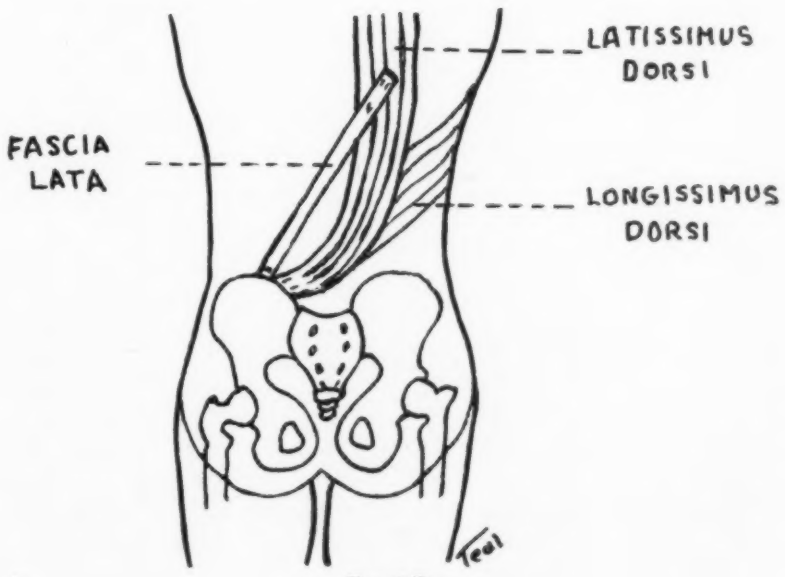

FIG. 3-B

Showing the transference of the muscles of the abdomen and of the back.

other methods could be utilized to supplant any deficiency. Accordingly the following operations were performed on the patient.

Operation

The scoliosis and obliquity of the pelvis were corrected by the Carl Jones apparatus. The flexion, internal rotation, and adductor deformities had been previously corrected by operation.

On May 1, 1940, a portion of the right obliquus externus abdominis with fascial prolongation was transferred into the left side of the ilium near the anterior superior spine, and a fascial sling was made between the right rectus abdominis and the left anterior superior spine as follows:

1. An incision was made along the crest of the ilium on the right side and dissection was carried down to the iliac crest. The overhanging muscle was retracted upward, after which an incision was made through the periosteum. Dissection was carried down along the inner side of the ilium, freeing the iliacus which was allowed to retract to help relieve the flexor contracture of the hip. The periosteum was stripped off the ilium upward, taking with it the obliquus externus abdominis. About one-third of the obliquus externus abdominis was then separated from the remainder of the muscle. A piece of fascia lata, which had been previously removed from the left leg, was sutured to the free end of the obliquus externus abdominis. This fascia lata prolongation of the obliquus externus

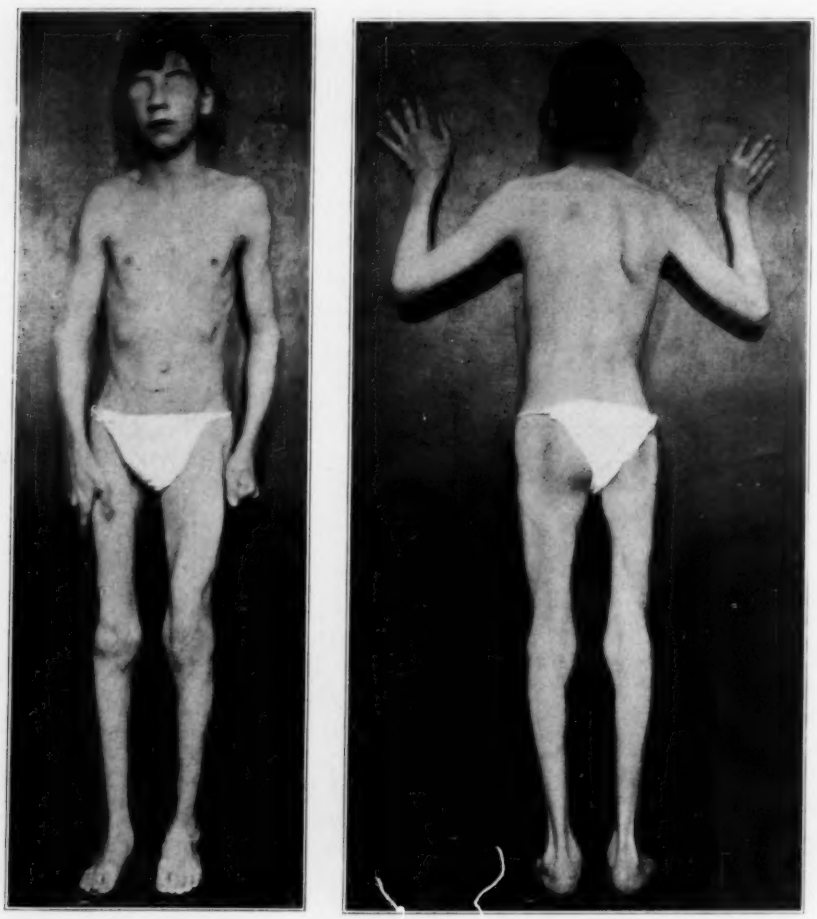

FIG. 4-A FIG. 4-B

November 8, 1941. Patient standing one year and five months after operation.

abdominis was passed across the abdomen in the subcutaneous fat to an incision made in the region of the anterior superior spine on the opposite side. The fascia was then passed through a hole drilled through the crest of the ilium at this place, turned back upon itself, and anchored with interrupted silk sutures. There was a little excess of fascia lata which was utilized in the second part of the operation.

2. An incision was then made over the junction of the upper and middle thirds of the right rectus abdominis. A second incision was made over the left rectus abdominis at a lower level,—in line with the anterior superior spine. An additional piece of fascia lata, which had been removed from the left thigh, was passed through the sheath of the right rectus abdominis and through a portion of the muscle, and then anchored to itself and the muscle with interrupted silk sutures. The free end was passed across the mid-line in the subcutaneous fat to the incision over the left rectus abdominis, where it was passed through the sheath and some of the muscle. Several interrupted silk sutures were inserted at this place. The fascia end was then brought down toward the left anterior superior spine, where it was sutured with interrupted silk sutures to the redundant piece of fascia lata from the first part of the operation, and also to the anterior superior spine of the left ilium (Fig. 3-A). The wounds were brought together with interrupted chromic sutures for the fat and fascia,

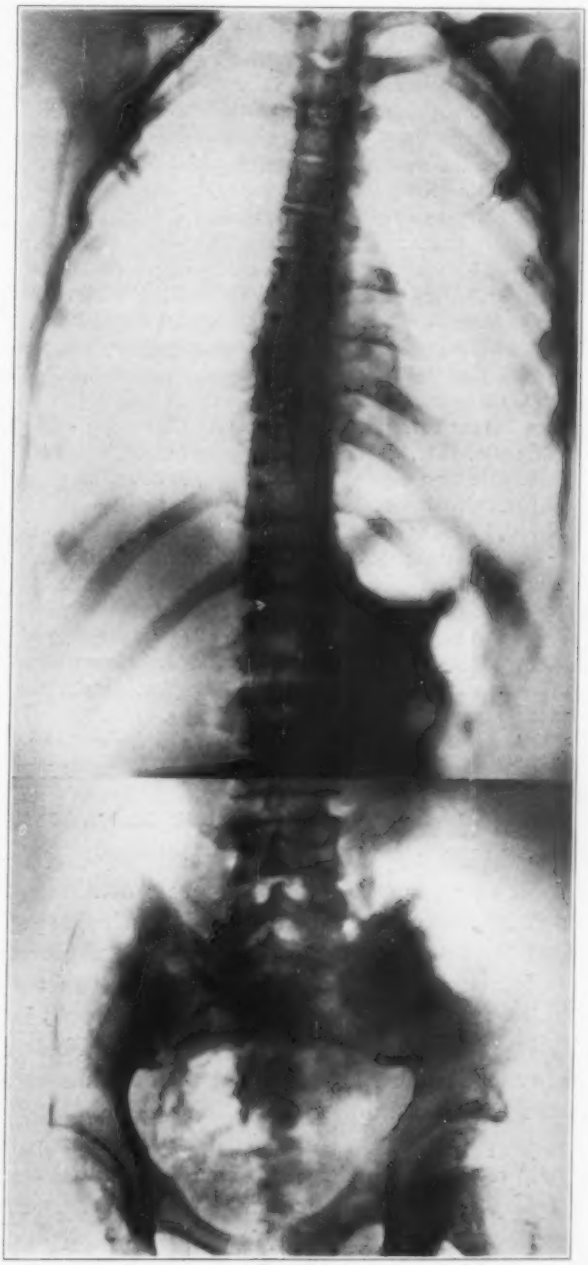

FIG. 5

June 11, 1942. Roentgenogram taken two years after operation, showing the correction of the spine and the obliquity of the pelvis.

and with silk sutures for the skin. A body jacket and left leg spica were applied, with the left extremity in abduction.

On June 1, 1940, the plaster casts were removed from the lower extremities preparatory to the second series of operations.

On June 5, 1940, the patient was placed face down on the operating table.

1. An incision was made over the upper portion of the iliocostalis lumborum. A piece of fascia lata, which had been removed from the left thigh, was anchored to the muscle and the overlying fascia of the latissmus dorsi with interrupted silk sutures. The strip of fascia was then passed diagonally downward in the subcutaneous tissue to an incision in the region of the posterior portion of the crest of the ilium, where it was anchored interosseally.

2. The sacrospinalis was exposed at its origin on the sacrum and the ilium, and a portion of the longissimus dorsi and iliocostalis were freed with the overlying fascia. The raised-up muscle was transferred to the region of the posterior superior spine of the ilium of the opposite side, and was anchored with interrupted silk sutures (Fig. 3-B). The wounds were sutured with interrupted chromic for the deep layers and with silk for the skin. A double plaster spica was applied on completion of the operation.

On June 28, 1940, both feet were stabilized by a Hoke type of operation.

On August 20, 1940, walking with crutches and a short leg plaster was started, the spica having been previously removed. He was discharged from the Hospital on September 25, 1940, walking with long leg braces, which he continued to use until May of 1941. He then used a cane to assist him in walking.

Examination on May 1, 1941, showed a little shift of the body to the left when he walked, but as he stood, the pelvis appeared well balanced. There was no scoliosis.

On November 8, 1941, about one year and five months after the muscle transferences, as he stood, the spine appeared straight, but when he walked, the right side of the pelvis was elevated a small amount. The bands of muscle were visible beneath the skin. There was three-quarters of an inch of real shortening of the right lower extremity, and this was compensated by a lift on the shoe. He was showing gradual slow improvement in his gait and balancing powers. The photographs taken from the front and back are shown in Figures 4-A and 4-B.

At the last examination, March 19, 1942, about one year and nine months following the final operation, the correction of the deformity was found to be fully maintained.

DISCUSSION

Spastic scoliosis and pelvic obliquity can be corrected and maintained by the proper muscle transference operation. It is important to obtain a balancing of the muscle pull on both sides of the pelvis and rib cage.

It is possible that the same type of correction could be secured in early paralytic scoliosis before fixed contracture and structural changes had taken place in the vertebrae. It would be necessary to know definitely which group of muscles are involved before any muscle transference operation could be performed. Unfortunately, it is not easy to determine this fact in many cases of scoliosis.

Transference of muscles in association with fusion operations may help to reduce the loss of correction and the tendency to recurrences following fusion operations for scoliosis of the spine.

THE INFLUENCE OF SODIUM-BETA-GLYCEROL-PHOSPHATE UPON THE HEALING OF EXPERIMENTAL FRACTURES *

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The study of the reparative processes following fracture of bone has been the subject of intensive study. While the cytological changes are fairly well understood and have been described by many workers, the exact chemical processes involved are still not entirely clear.

In 1923 Robison discovered that bone contains a ferment which he called phosphatase. This enzyme hydrolyzes available phosphoric esters and increases the concentration of phosphate ions beyond the level of solubility of calcium phosphate, so that the salt is deposited in the callus. There is no conclusive evidence that delay in the healing of fractures, or calcification of the hematoma, is due to a quantitative deficiency of phosphatase[1]; nor is there any evidence that the delayed healing is due to absence of sufficient mineral salt at the site of the fracture. Urist recently stated that the bone salt originating locally in necrotic bone or implanted in the callus is absorbed without influence upon the progress of calcification of the new bone and cartilage matrix.

The humoral source of bone salt is essential for the normal process of healing, and, according to Urist, cannot be entirely replaced by local sources of mineral without considerable delay in the uniting of fractures.

The erythrocytes contain an abundance of phosphoric esters hydrolyzable by phosphatase[2], but the plasma, while containing normally a sufficient concentration of calcium, contains only minute amounts of ester phosphorus hydrolyzable by phosphatase,—two-tenths to five-tenths of a milligram of phosphorus per 100 cubic centimeters[3]. It appears possible that one of the factors limiting the speed of the process of calcification is the low content of plasma in this substance essential to the precipitation of calcium in callus, and in new-bone formation. It seemed desirable, therefore, to investigate the effect of the intravenous injections of sodium-beta-glycerol-phosphate on the rate of healing of fresh experimental fractures. As far as can be determined, this ester of phosphoric acid has not previously been used in experimental or clinical studies on the healing of fractures.

METHOD

The right radius of rabbits, weighing between four and one-quarter and four and three-quarters pounds, were fractured under ether anaesthesia. The fractures were produced by grasping the middle of the shaft

* This work was supported by Grant 577 of the Committee on Scientific Research of the American Medical Association and by the Graduate School of the University of Minnesota.

of the bone between two adjacent and parallel Kocher forceps and exerting steady force in opposite directions until the bone was fractured. A few animals, in which breaks of both the radius and ulna were produced, or which displayed marked bruising of the skin or compounding of the

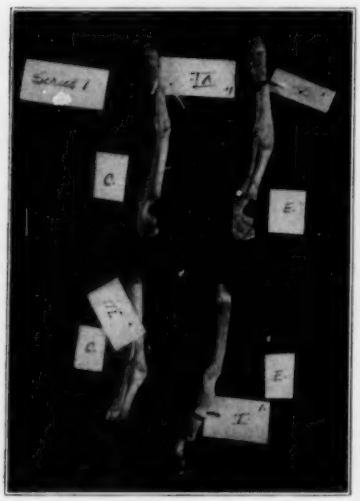

FIG. 1-A

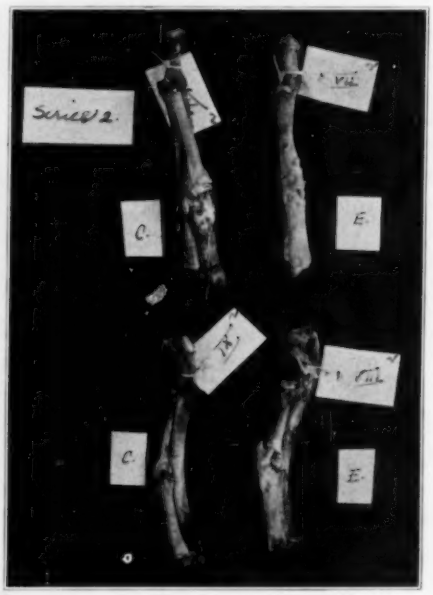

FIG. 1-B

FIG. 1-C

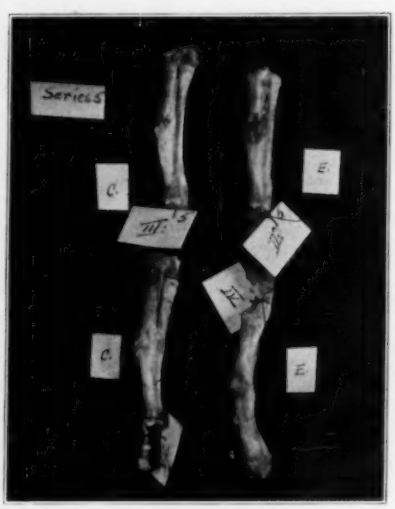

FIG. 1-D

Photographs of fractures of rabbits' radii of nine to fourteen days' duration.
E.: Experimental animals which were given daily injections of sodium-beta-glycerol-phosphate.
C.: Control animals, given daily injections of physiological normal saline.

fracture, were discarded. Roentgenographic examination revealed that the fractures usually were transverse, and that the fragments were in alignment with little comminution of the bone. The undamaged ulna served as an effective splint and the animals were able to use the limb upon recovery from the anaesthesia.

Twenty-seven animals of the experimental group received six to fourteen daily injections, by ear vein, of one-tenth of a gram of sodium-beta-glycerol-phosphate in four cubic centimeters of solution. Twenty-two animals with similar fractures served as controls, and received a like number of injections of four cubic centimeters of physiological saline. All rabbits were sacrificed the day following the last injection.

RESULTS

Roentgenograms of the limbs, taken before and after removal of the soft tissues, revealed an increase in callus about the fracture site in the group treated with sodium-beta-glycerol-phosphate. The fracture callus of the animals receiving eight to fourteen treatments with sodium-beta-glycerol-phosphate was greater in amount and more firm to palpation than that of the control animals. After cleaning the bones, it was noted that, even though some of the callus was lost when the periosteum was removed, the healing of the fracture appeared to have progressed further in the animals treated with sodium-beta-glycerol-phosphate. The hard callus of the treated animals was larger, and the fracture defect was more nearly bridged over, than in the controls. In the treated group it was noted, on stripping the periosteum, that much callus was adherent to the periosteum; while in the untreated group the periosteum stripped off easily with no adherent callus. Examples of the different stages of progress in healing of the fractures of animals treated with sodium-beta-glycerol-phosphate and with physiological saline are shown in Figures 1-A, 1-B, 1-C, and 1-D. A more objective means of estimating the degree of union

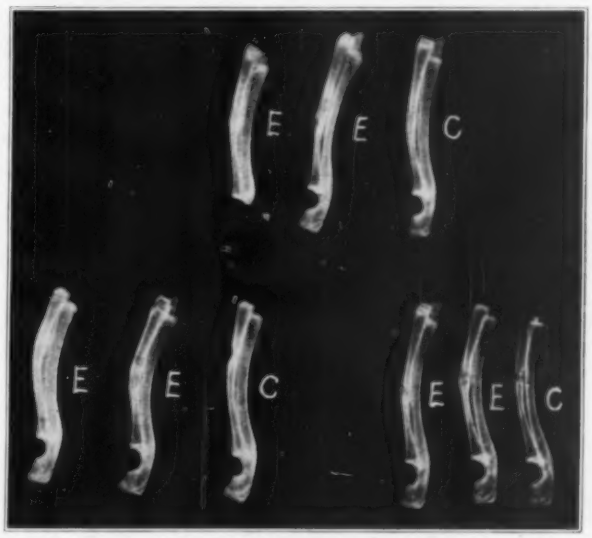

FIG. 2

X-rays of fractured radii of rabbits after ten days. Note the greater amount of callus in experimental animals.
E.: Experimental animal. *C.*: Control animal.

would be desirable. Further experiments are in progress and will be reported later. The authors' observations indicated that the drug, in the majority of cases, exerted a positive effect, even though the fractures with which the authors were dealing normally progress to rapid healing. Four determinations of serum inorganic phosphate and calcium, made at regular intervals during the course of twelve daily injections of one-tenth of a gram of sodium-beta-glycerol-phosphate into rabbits, showed no consistent differences from the results obtained with untreated animals.

STUDIES ON TOXICITY OF SODIUM-BETA-GLYCEROL-PHOSPHATE

Sodium-beta-glycerol-phosphate, when given by intravenous injection over a long period of time or in large doses, is not toxic. The liver, intestine, urinary bladder, kidney, heart, and aorta of all experimental animals were normal grossly and microscopically, as were those of a rabbit which received fifty-five daily injections of one-tenth of a gram of the drug. Similar results were obtained with three rabbits following six daily intravenous injections of one gram of the substance. No symptoms were produced following twenty-six daily subcutaneous injections of one-tenth of a gram of sodium-beta-glycerol-phosphate into a rabbit, and no pathological findings were noted at autopsy. A dog weighing seventeen kilograms received ten daily intravenous injections of ten grams of the substance in forty cubic centimeters of solution. No ill effects were produced, and when the animal was sacrificed, two months after the last injection, no pathological alterations of any organ were observed. Massive doses (twelve to twenty-four cubic centimeters of a solution containing 0.25 gram of the substance per cubic centimeter) were fatal in two to five days when given each day to rabbits by intraperitoneal injection. This was probably due to the administration of a massive hypertonic solution.

CONCLUSIONS

Sodium-beta-glycerol-phosphate is an innocuous drug,—readily available for further experimental and clinical studies. It is apparently well tolerated by the experimental animal in a dosage of wide range, and seems to stimulate and hasten the reparative process and the production of bone callus. More histological and chemical studies are in progress. The clinical trial of sodium-beta-glycerol-phosphate is suggested.

REFERENCES

1. Botterell, E. H., and King, E. J.: Phosphatase in Fractures. Lancet, I, 1267, 1935.
2. Kay, H. D., and Robison, Robert: The Possible Significance of Hexosephosphoric Esters in Ossification. Part III. The Action of the Bone Enzyme on the Organic Phosphorous Compounds in Blood. Biochem. J., XVIII, 755, 1924.
3. Martland, Marjorie, and Robison, Robert: The Possible Significance of Hexosephosphoric Esters in Ossification. Part VI. Phosphoric Esters in Blood-Plasma. Biochem. J., XX, 847, 1926.
4. Robison, Robert: The Possible Significance of Hexosephosphoric Esters in Ossification. Biochem. J., XVII, 286, 1923.
5. Urist, M. R.: Calcification and Ossification. III. The Rôle of Local Transfer of Bone Salt in the Calcification of the Fracture Callus. J. Bone and Joint Surg., XXIV, 47, Jan. 1942.

IMMERSION FOOT *

BY SURGEON COMMANDER D. R. WEBSTER, SURGEON LIEUTENANT F. M. WOOLHOUSE, AND SURGEON LIEUTENANT J. L. JOHNSTON, HALIFAX, NOVA SCOTIA, CANADA

"Immersion foot" is the name used to denote a condition produced by long immersion of the feet in extremely cold water, usually associated with immobility of the limbs and constriction of the limbs by boots and clothing. This is a similar condition to "trench foot" and "shelter foot" (described by Knight), but until this war it has received little study by naval surgeons.

We have had the opportunity to observe 142 of these cases, almost all the result of enemy action in the North Atlantic. The patients had been in lifeboats or rafts for periods varying from thirty hours to twenty-two days, the boats almost always containing water to a depth of several inches in spite of constant bailing. The only recorded temperatures of the water showed it to be from 34 to 36 degrees Fahrenheit, and, as the freezing point of sea water is approximately 28.5 degrees Fahrenheit, the feet may well have been exposed to surface cooling below the freezing point of blood, which is 31 degrees Fahrenheit.

At the time of removal of the patients from the open boats or rafts, the feet were cold, swollen, and waxy white in color, with scattered cyanotic areas. The patients complained at that time that their feet felt heavy, "woody", and numb, and the feet were anaesthetic to pain, touch, and temperature.

Shortly after removal of the feet from this traumatizing environment, the swelling increased rapidly as the feet became red, hyperaemic, and hot without sweating, and the pulse in the vessels of the feet was full and bounding. In those more severely damaged areas—usually the toes, the distal part of the dorsum of the foot, and the ball of the foot—the parts remained oedematous and hot, and assumed a livid, cadaveric appearance. A number of these latter areas later produced blebs, some of which were filled with straw-colored fluid and others with extravasated blood; and areas of ecchymosis commonly appeared over the medial aspect of the first metatarsophalangeal joint and on the medial aspect of the longitudinal tarsal arch. Many of these feet presented the appearance of incipient massive gangrene. The rapid swelling and increasing redness, accompanied by the extreme rise in temperature of the part, presented the picture of an intense vasodilatation, accompanied by definite damage to the vascular wall with transudation, as manifested by bleb formation and extravasation of blood.

The anaesthesia followed a variety of patterns. In the mildest cases these areas extended around the margins of the foot and over its plantar

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aspect, being of greater extent along the lateral border where the mass to surface ratio is smallest. In the more severe cases these areas extended over the entire dorsum of the foot, and in some cases over the lower two-thirds of the leg. Patches of anaesthesia over the knees in the prepatellar and infrapatellar regions were observed in two cases where there had been prolonged kneeling in the lifeboats.

A similar picture was recently observed by one of us (D.R.W.) among survivors landed at the Marine Hospital at Norfolk, Virginia. These men were in the Gulf Stream where the water was between 60 and 70 degrees. Cold could not have been a factor there, but immersion of the feet in sea water over a period of eight days resulted in gangrene and sensory changes similar to those observed in the Halifax series, in which cold was an indubitable factor in the production of immersion foot.

In all cases treated, the initial anaesthesia and hypaesthesia were replaced by intense paraesthesia on the eighth to tenth day after removal from the traumatizing agent. The paraesthesiae were described as, first, an intense burning sensation over the surface of the entire foot, persisting for approximately one day; this was then replaced by an intense, intermittent, stabbing, shooting pain, which commenced in the ankle joint or the midtarsus and radiated to the tips of the toes, with a generalized tingling sensation in the foot during the interval between the stabbing pains. The paraesthesiae subsided as they gradually receded distally to the metatarsal pad and the pads of the toes. This process occupied a period of from three to four weeks, persisting longest in the older men with arteriosclerotic changes apparent in the radial artery at the wrist.

Because of the picture of intense vasodilatation with transudation of serum and of blood, and the subsequent profound inflammatory reaction with its concomitant increase in the metabolic demands of the tissues involved, a clinical trial of treatment of "immersion foot" by dry refrigeration was made at Camp Hill Hospital, Halifax, Nova Scotia.

The tragic results from too rapid warming of these feet have been so frequently demonstrated that it is only mentioned for emphasis.

A considerable literature on the effect of low temperature on tissue survival has accumulated. According to Freeman, "Gangrene results from a discrepancy between the demands of the tissues and the supply of blood to meet these nutritional needs", and, in reporting on the development of gangrene in peripheral vascular disease, he stated the belief that the affected part should be kept at a temperature of from 30 to 34 degrees. Starr likewise concluded that maintenance of temperature between 30 and 40 degrees is most favorable for increasing circulation and inhibiting oxidation.

Brooks and Duncan, experimenting with rats' tails, stated that temperature is a powerful factor in determining the length of time that tissue rendered anaemic remains viable. Allen, working with loops of intestine rendered ischaemic by ligation or tourniquet, found that gan-

grene occurred in from three to three and one-half hours, if temperature was kept at from 40 to 41 degrees Fahrenheit, but did not occur in fifty-four hours if the temperature was kept at from 0 to 2 degrees centigrade. Lewis' classical work likewise demonstrated that tissue remains viable at temperatures well below freezing.

Greene, in his extensive experience with frostbite, concluded that the trauma of immersion foot is similar to that of frostbite or shelter foot, stating that "it is difficult to see how treatment producing vasodilatation could possibly do anything but harm in the acute stage".

Smithwick and White have recorded the beneficial effects of sympathectomy in saving tissue and in relieving pain in peripheral vascular disease. In immersion foot, however, the sympathetic supply to the feet appears to be absent, as indicated by the lack of sweating in the affected parts, by the vascular sensitization to adrenalin demonstrated in our cases by Lieutenant Commander J. C. White, U.S.N., and by the fact that the temperature of the feet is higher than that usually associated with sympathectomy. Therefore, no advantage would be gained by ganglionectomy, as suggested in a number of articles in the French literature (Soupault and Orsoni, Simon and Filhoulaud, Forster and Wiederkehr, and Stricker and Buck).

There appears to be a marked variation in the individual response to this form of trauma. Knight has attributed this in part to a nutritional deficiency. We have observed in our series that those who suffered the most severe damage were Greeks, Australians, negroes, and those employed in engine-room or stokehold duties. This suggests that those accustomed to a warm environment may not have the same defences as those who have been exposed to colder climates.

CLINICAL TRIAL OF TREATMENT

The following is an initial report of the clinical trial of treatment mentioned earlier in the paper:

Classification of Immersion Foot

This condition was classified in four groups, as follows:

I. Minimal case: that showing only erythema with slight sensory changes.

II. Mild case: that showing pitting oedema, erythema, and sensory changes.

III. Moderate case: that showing pitting oedema, erythema, blebs, and ecchymotic spots.

IV. Severe case: that showing gross pitting oedema, blebs, massive extravasations of blood, and incipient gangrene.

Classified in this manner, the cases treated were distributed as follows:

Group I	*Group II*	*Group III*	*Group IV*
39 cases	38 cases	50 cases	15 cases

Method of Treatment

The methods of refrigeration used were those which could be applied expeditiously with the facilities at hand, and do not represent ideal methods of employing dry cold. Apparatus is being constructed which will produce uniform dry cold, and the results of the use of this apparatus will be reported later.

Dry cooling and refrigeration were achieved in the present series by the following means:

A. *Application of ice bags:* The traumatized feet were carefully swabbed off with alcohol; sterile pledgets of gauze were placed between the toes; and the whole foot in each case was covered with a sterile towel. During this procedure the feet were handled as little and as gently as possible. Five carefully dried ice bags were placed around each foot over the towel, and the whole enclosed in an oiled-silk bag. This was then wrapped in thick layers of cellucotton, and enclosed in rubber pillowcases loosely tied about the upper calf of the leg. The feet were then elevated on several pillows. The ice bags were changed every four hours except in those cases of extreme hyperaemia in which more frequent changing was necessary to result in an average lowering of the temperature of the foot of about 6 degrees centigrade.

B. *Dry cooling by exposure to fan:* The feet were exposed and elevated in front of electric fans, which drove a continuous blast of air across the traumatized areas. To enhance cooling, the feet were repeatedly sprayed through the fan blades with cold water from a nebulizer.

C. *Dry cooling at room temperature:* The feet were elevated and completely exposed to room temperature in a cool ward.

Skin temperatures were taken with a dermatherm three times a day over four areas of the feet, as indicated by Figure 1.

Results of Treatment

Within a few hours after application of the ice bags, the patients were completely comfortable. The oedema rapidly subsided to such an extent that in many cases the skin was wrinkled at the end of four hours. This cannot be due to posture alone, because it has been observed repeatedly that the oedema returns when the ice bags have been removed for as short a time as thirty minutes.

The two varieties of blebs described—those filled with straw-colored fluid and those filled with extravasated blood—were resorbed without breaking. These blebs refilled if the ice was discontinued prematurely, but became resorbed again when the ice was reapplied.

All patients in Groups I, II, and III, with one exception—a patient who succumbed following the development of empyema and staphylococcic septicaemia—recovered completely after superficial desquamation over the entire foot and a brief period of reeducation necessitated by an abnormal gait. The average period of hospitalization of these patients was 30.4 days.

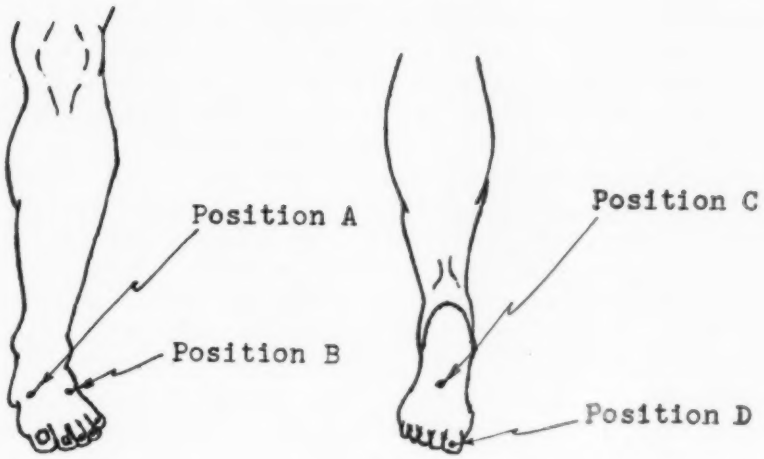


FIG. 1

Of the fifteen patients in Group IV, seven have been discharged from the Hospital after the loss of small areas of superficial tissue, which healed rapidly and did not require grafting. The remainder are still confined to the Hospital. In five of these cases, gross tissue defects have developed across the mid-dorsum of both feet, which in the early stages of the condition represented the final demarcation of normal and damaged tissue. In two of these cases (D. K. and H. C.) the defect appeared as a band encircling the foot, beyond which the tissues seemed healthy, but infection supervened and led to gangrene in the distal portion of the foot. Passive vascular exercise by means of the paevex boot was used in some cases, but no benefit from this treatment was noted. In two cases, the superficial skin over the distal aspect of both feet has become mummified and is being shed, leaving healthy tissue with epithelial islands throughout.

In one case (D. R.), in which ice bags were applied for four weeks, the tissues of the feet assumed a healthy pink color, and the ice bags were removed. The feet were permitted to return to room temperature, and within eight hours a large quantity of blood was extravasated into the subcutaneous tissues. The feet became greenish-gray in color, with a sharp line of demarcation between healthy and damaged tissue encircling the mid-tarsal region of both feet, and tissue breakdown occurred. This will progress ultimately to extensive tissue loss over the distal aspect of both feet.

One patient (R. B.), in the group still hospitalized, suffered severe contusions of the lower legs while transferring from a lifeboat to a rescue ship, after the development of immersion foot. He was admitted to the Hospital with his legs grossly swollen and hyperaemic, and the skin over the distal third of each leg and foot was livid. On the fourth day of his hospitalization the patient became extremely ill, and tenderness

and enlargement of the liver developed. This was followed in twenty-four hours by the onset of pneumonitis and acute pulmonary oedema. Recovery from these complications was slow, but, during the entire time, the oedema in the feet and legs subsided with gross wrinkling of the skin over the feet. The skin over the heels and across the proximal dorsum of the feet became macerated and mummified, and is now being shed, leaving healthy granulations. A tendency to drop-foot is being corrected by mechanical means.

In the cases of D. P. and C. Y. F., infection and cellulitis developed from a focus of epidermophytosis at the base of the fifth toes. These patients were treated with sulphathiazole by mouth, and, while the infection subsided, loss of tissue occurred, necessitating, in the case of C. Y. F., the amputation of the left great toe at the metatarsophalangeal joint, both fifth toes, and the left third toe at the proximal interphalangeal joint.

In the case of P. N., originally treated with ice bags and then by constant fanning, a dry gangrene developed in the left foot, which progressed to involve the foot to the mid-tarsus. Amputation of the left foot at the site of election was performed after thirty-four days' hospitalization. The patient's right foot has recovered completely with loss of superficial epithelium.

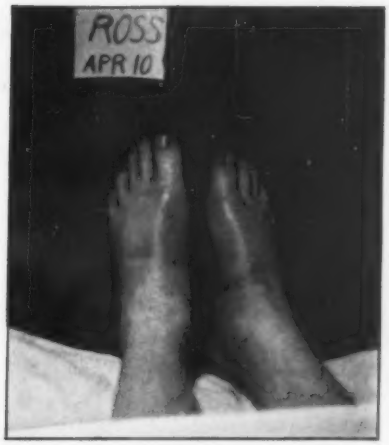
Large doses of vitamin B_1 failed to alleviate the neuritic pains, and, in some cases, the patients complained that their distress was increased shortly after the administration of the drug.

It is noteworthy that the application of ice bags in these cases, whether or not the patients had been treated initially with ice, relieved the severe pain in about an hour. In some cases in which the weight of the ice bags was intolerable, the patients made voluntary effort to cool the feet by putting them in the open windows of the ward.

In five cases, pain and redness occurred along the course of the veins on the dorsum of the feet; and in one case, along the course of the saphenous veins in both thighs. In the first five, there were showers of petechiae in the juxtaposed skin. In two cases, segments of the veins were palpably thrombosed, but in no case was there noted an accompanying febrile reaction. This complication appeared with about equal frequency in those patients treated with ice bags and in those not so treated.

In a large number of those cases in Groups II, III, and IV, following the disappearance of the paraesthesia and the voluntary assumption of up-privileges, the patients were found to have a grossly altered gait. They first walked with a slapping, flat-footed, springless gait, which gradually improved in about seven days. At the end of this period they had regained normal "take-off" from the toes, and were able to stand on tiptoe without undue effort or discomfort. In two cases a transient bilateral paresis of the fourth and fifth toes was noted, recovery taking place in seven days. Follow-ups on many of these patients proved that

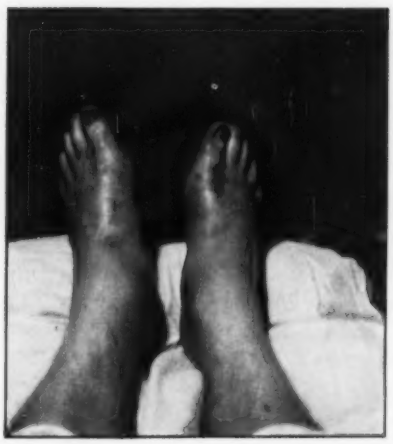
D. R. Showing condition on admission.



D. R. After seven days of ice-pack treatment.

R. D. On admission.

C. Y. F. On admission.



H. C. After seven days of ice-pack treatment.

H. S. After seven days of ice-pack treatment.

FIG. 2

pain recurs if the feet are subjected to cold and wet, or if long walks are undertaken.

In one case a transient hematuria and albuminuria occurred and persisted for forty-eight hours. Also, three patients had a generalized toxic febrile reaction with enlargement and tenderness of the liver during their first week of hospitalization. It is noteworthy that in this group of survivors, exposed to the elements for from one to twenty-three days, upper respiratory infections occurred in only two cases. In all of the cases in which the patients were hospitalized within a few hours of rescue, there was a very appreciable febrile reaction, the average temperature rise being to approximately 100.5 degrees; in most cases under observation this temperature subsided in the first twelve to thirty-six hours of hospitalization.

DISCUSSION

The rationale of this treatment rests on the presumption that the tissue damage caused by the original trauma results in an intense vasodilatation, together with actual damage to the vessel walls and damage to peripheral nerves or end organs. A vicious circle is thus established, with a resulting oedema and transudation of serum and blood, all of which further contribute to the already present oxygen debt in the involved part. This latter, in turn, leads to an increase in oedema and transudation of whole blood. It was believed that, if the metabolic demands of the part—which, of course, are great, because of the reaction to tissue injury with the concomitant rise in local temperature—could be reduced until the oedema subsided, the extravasated blood was resorbed, and the vasomotor tone was reestablished, the tissue damage would be greatly ameliorated. At present it is not known how much of the fluid loss from the vessels is due to actual damage to the vascular wall, and how much is due to the loss of neurogenic control of the vessels.

Strict asepsis is essential in handling these cases because in those patients in whom infection developed in the damaged tissues of the feet, the infective process spread with great rapidity through all layers of the feet. This process was observed to occur in some cases without apparent break in the skin surface. The heels are also prone to severe tissue damage, due to pressure, and should be carefully guarded by means of padded rings or suspension apparatus.

In the series of cases studied, no cases of extreme emaciation were seen, and all patients desired and tolerated a normal full diet from the time of admission to the Hospital. We observed no sign of acute vitamin deficiency, such as stomatitis, cheilosis, hemorrhages, or visual disturbances, which were noted in the survivors landed at Norfolk. Dehydration was not a complicating factor in the present series, as these men were survivors of sinkings by enemy action in the waters of the North Atlantic and had a plentiful fresh-water supply and were not exposed to tropical heat at any time.

From our clinical observations and from the small amount of histological material available, it is apparent that there is an extending thrombosis in the vessels adjacent to the traumatized area. It is suggested that heparin would be of value in the early cases of Group IV. Our experience in the use of heparin is limited, but we believe that in one case presenting a clinical picture of vascular occlusion, heparinization was responsible for saving the involved limb. In tissues irreparably damaged, we believe that dry refrigeration, while postponing the inevitable gangrene, leads to a minimal tissue loss.

There are many unsolved problems in the study and treatment of immersion foot,—such as nerve dysfunction, vascular damage, the formation of H substance, and remote toxic effects.

SUGGESTED PROPHYLAXIS

Boots and any constricting footwear, if wet, should be removed, and oil or heavy grease should be generously applied to the feet while the seaman is exposed.

It is suggested that on rescue the patient should be lifted, if possible, and not be permitted to walk. No massage should be attempted, and the feet should be exposed and elevated and the patient given supportive treatment.

In the hospital strict asepsis should be maintained, and the feet should be cooled, if possible, during the hyperaemic period.

SUMMARY

1. This report is based on the observation of 142 cases of immersion foot at Camp Hill Hospital, Halifax, Nova Scotia.

2. This condition may occur in those exposed for long periods in subtropical waters and thus cannot be classed as a true frostbite.

3. Sensory loss and hyperaemia appear first and are followed in about ten days by intense neuritic pains, and, in severe cases, by varying degrees of gangrene.

4. Dry refrigeration appears to be successful in reducing tissue loss to a minimum.

5. Return of sensation and complete motor control may be delayed for many weeks, and pain may recur on exposure to cold and wet.

6. First aid and hospitalization should be directed to avoidance of trauma, slow warming of affected limbs, strict asepsis, and adequate supportive treatment.

We are indebted to the Department of Pensions and National Health for segregating these cases for our observation and study, to Surgeon Lieutenant D. Y. Solandt, R.C.N.V.R., for much valuable aid, and to Lieutenant Commander J. C. White, U.S.N., for many helpful suggestions. We are also grateful to the staff of The Marine Hospital, Norfolk, Virginia, for the generous demonstration of their cases.

REFERENCES

ALLEN, F. M.: Resistance of Peripheral Tissues to Asphyxia at Various Temperatures. Surg. Gynec. Obstet., LXVII, 746, 1938.

Surgical Considerations of Temperature in Ligated Limbs. Am. J. Surg., XLV, 459, 1939.

Experiments Concerning Ligation and Refrigeration in Relation to Local Intoxication and Infection. Surg. Gynec. Obstet., LXVIII, 1047, 1939.

BROOKS, BARNEY, AND DUNCAN, G. W.: The Effects of Temperature on the Survival of Anemic Tissue. An Experimental Study. Ann. Surg., CXII, 130, 1940.

FORSTER, E., ET WIEDERKEHR, I.: Infiltrations stellaires pour gelures de la main. (Rapport.) Mém. Acad. de Chir., LXVI, 367, 1940.

FREEMAN, N. E.: Influence of Temperature on the Development of Gangrene in Peripheral Vascular Disease. Arch. Surg., XL, 326, 1940.

GREENE, RAYMOND: Frostbite and Kindred Ills. Lancet, II, 689, 1941.

KNIGHT, B. W.: "Trench Foot" in Civilians. British Med. J., II, 610, 1940.

LEWIS, SIR THOMAS: Observations on Some Normal and Injurious Effects of Cold upon the Skin and Underlying Tissues. I. Reactions to Cold, and Injury of Normal Skin. British Med. J., II, 795, 1941.

II. Chilblains and Allied Conditions. British Med. J., II, 837, 1941.

III. Frost-Bite. British Med. J. II, 869, 1941.

SIMON, RENÉ, ET FILHOULAUD, HENRI: Gelures des pieds traitées avec succès par des infiltrations anesthésiques lombaires et par des sympathectomies. Mém. Acad. de Chir., LXVI, 359, 1940.

SMITHWICK, R. H., AND WHITE, J. C.: Elimination of Pain in Obliterative Vascular Disease of the Lower Extremity. A Technique for Alcohol Injection of the Sensory Nerves of the Lower Leg. Surg. Gynec. Obstet., LI, 394, 1930.

Peripheral Nerve Block in Obliterative Vascular Disease of the Lower Extremity. Further Experience with Alcohol Injection or Crushing of Sensory Nerves of Lower Leg. Surg. Gynec. Obstet., LX, 1106, 1935.

SOUPAULT ET ORSONI: Pieds gelés (infiltration du sympathique lombaire). Mém. Acad. de Chir., LXVI, 358, 1940.

STARR, ISAAC, JR.: On the Use of Heat, Desiccation and Oxygen in the Local Treatment of Advanced Peripheral Vascular Disease. Am. J. Med. Sciences, CLXXXVII, 498, 1934.

STRICKER, T., ET BUCK, F.: Traitement des pieds de tranchée par les infiltrations de scurocaïne du sympathique lombaire. Influence sur les douleurs et les phénomènes ischémiques. Mém. Acad. de Chir., LXVI, 235, 1940.

LOCALIZED FIBROCYSTIC DISEASE OF BONE

Results of Treatment in One Hundred and Fifty-Two Cases * †

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More than six years ago a study of the different forms of fibrocystic disease of the bones was undertaken by the writer, on a series of cases collected from various sources. That study, carried out at the Hospital for the Ruptured and Crippled (now the Hospital for Special Surgery) in New York under the direction of P. D. Wilson, M.D., and staff, included a clinical, roentgenographic, and pathological survey of 152 cases of localized fibrocystic disease, or the so-called bone cyst.

Forty-eight of these cases were found in the records of the Hospital for the Ruptured and Crippled, and had been treated by different members of the staff over a period of about twenty-five years. Twenty-six were from the Bone-Tumor Service of B. L. Coley, M.D., at the Memorial Hospital, and fifty-three cases were taken from the Registry of Bone Sarcoma of the American College of Surgeons. The other twenty-five cases were obtained through the courtesy of individual surgeons: R. D. Schrock, M.D., and H. F. Johnson, M.D., of Omaha, A. R. Shands, Jr., M.D., of Wilmington, and P. C. Colonna, M.D., of Oklahoma City, contributed most of these. Great care was necessary so as not to duplicate these cases, since many of the cases from the hospitals and from individuals were on record in the Registry of Bone Sarcoma of the College of Surgeons.

The purpose of this paper is to present very briefly a summary of the end results of the different methods of treatment used in this group of cases. The various methods of treatment used were as follows:

I. No treatment except for pathological fracture when present (22 cases).
II. Irradiation alone (15 cases).
III. Irradiation combined with surgery:
    1. Cases in which surgery was resorted to because of unsatisfactory results from irradiation (8 cases).
    2. Other cases in which irradiation was used, preoperatively or postoperatively (10 cases).
IV. Surgery:
    1. Amputation (7 cases).
    2. Resection or ostectomy, sometimes combined with bone graft (11 cases).

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, New Orleans, Louisiana, January 14, 1941.

† The work was aided by a Fellowship Grant from the Nemours Foundation, Wilmington, Delaware (A. R. Shands, Jr., M.D., Medical Director).

3. Curettage alone as primary treatment (36 cases).
4. Curettage and cauterization (21 cases).
5. Primary curettage and the use of bone chips (9 cases).
6. Secondary curettage and the use of bone chips (8 cases).
7. Primary curettage and the use of a massive graft (13 cases).
8. Secondary curettage and the use of a massive graft (3 cases).

The above groups were considered separately and results determined for each form of therapy. In recording the end results of these cases, they were graded according to the anatomical and functional results, and the roentgenographic appearance of the bone. Each of these three headings was given five possible ratings from 0 to 4. The poorest results were graded 0 and the best were graded 4.

The anatomical result included shortening, deformity, and the arrest of epiphyseal growth. The functional result was rated upon the ability of the individual to use the part, whether it was a weight-bearing bone or not; pain, limp, and limitation of joint motion were considered under this heading. The roentgenographic result depended upon the presence or absence of a cystic lesion, and its extent. The results were graded 4 when the lesions were completely healed. They were graded down if even a minute cystic lesion persisted. Recurrent lesions following treatment were graded 0. Lesions of the jaws and skull were not considered in the general grouping, because end results in these cases depend upon different criteria. They were therefore considered separately.

Cases in which there was no operation or biopsy could not, of course, be positively diagnosed, but all those included showed lesions which originally were considered to be bone cysts. Operation was not done, either because of the physician's belief that fracture would cure the lesion, or because the patient refused operative treatment.

All cases included in this study were reviewed by the writer and the results were graded uniformly by the above method.

NO TREATMENT EXCEPT FOR FRACTURE WHEN FRACTURE WAS PRESENT

There were twenty-two cases in this group, eleven of which had one or more pathological fractures. Most of these were simply treated for the fracture in the belief that cure of the lesion would follow. In no case treated in this manner was a completely satisfactory result obtained. In several cases fracture recurred later, in some many times, but even in those in which there was no recurrence at the time of follow-up examination, the roentgenogram showed a residual unhealed cavity in the presence of varying degrees of function. The results were poorer in the weight-bearing bones than they were in the non-weight-bearing bones.

Eleven patients in this group had had no fracture, but complained of pain or limp. The results are known in five of these cases and unknown in six. All of the five patients for whom the results are known had continued to have some type of pain for from three to sixteen years. The lesions as shown by the roentgenogram either remained the same or slowly

progressed in size. Gradually increasing deformity was noted in some of these patients, especially in the weight-bearing bones. In no case was healing spontaneous without treatment.

IRRADIATION ALONE

There were fifteen patients who had irradiation as the only method of treatment. The results are known in all except one case. In six cases the results were definitely poor. Apparently, there were some harmful results. Some patients sustained fractures from one to four years following treatment. In one patient, a malignant change took place, and amputation, eight years after the beginning of treatment, was followed by death from metastases. The history of this case is as follows:

CASE No. 77. The patient, a female, when first seen in 1913 at the age of 13, gave a history of a gradual onset of pain in the right leg which had started six years previously. The pain had originally begun as a sharp sudden pain with swelling in the upper tibia. After a few days the swelling had become normal and the pain had subsided. She had no further symptoms until six years later (1919). At this time she had another attack of pain in the leg accompanied by swelling. Examination revealed an enlargement of the upper third of the tibia with slight localized tenderness.

Roentgenograms revealed a localized cystic lesion, somewhat eccentric anteriorly at the junction of the upper and middle thirds of the tibia. The cortex was markedly thin and slightly perforated on the anterior aspect. No periosteal reaction was observed, and the contour of the oval-shaped cystic rarefaction was smooth and well outlined.

Radium irradiation was given on April 17 and 23, 1919.

The patient was seen from time to time and roentgenograms were interpreted as showing slight improvement. She continued to have slight pain at times and in 1922 was given further irradiation. Later mercury and iodides were given as a therapeutic test. There seemed to be slight improvement following this therapy. Further observation and roentgenograms through 1927 showed very little change in the local condition. By August 18, 1927, however, the lesion had enlarged as shown by the roentgenogram, and the pain had grown somewhat worse. She was given further irradiation at this time. The pain continued and the mass increased in size until she was admitted to the Hospital in 1928, at which time amputation at the mid-thigh was performed. She died from metastases in 1929. The pathologist's report was osteogenic sarcoma.

Although the diagnosis of localized osteitis fibrosa cystica was not confirmed by pathological sections before treatment was instituted, it seems fairly certain from a study of the available material that this was a benign bone cyst. Chondroma cannot be entirely ruled out, but it is rare in this location. That the lesion was originally a malignant one is very doubtful because of the duration of the condition before death finally intervened. This seems to be definitely an instance of malignancy which occurred in localized osteitis fibrosa cystica following irradiation.

In six other cases in this group better results were obtained, and patients who complained of pain as an original symptom were relieved of it. In no case in this entire series, however, was the result completely satisfactory from every standpoint. The patients having good function showed residual cavities in the roentgenograms. Those having a good anatomical result failed to obtain a good functional result, or also had residual cavities as shown in the roentgenograms.

PRIMARY TREATMENT BY IRRADIATION, FOLLOWED BY SURGERY

In eight cases originally treated by irradiation, the results were so unsatisfactory that operation of some type was later resorted to in an effort to improve the condition. At least a year had elapsed between irradiation therapy and operation in all but one case. This patient was operated upon one month following irradiation. In this case—a lesion of the trochanteric region of the femur—extreme decalcification followed irradiation therapy. Surgery was performed in the remaining cases from one to eight years following the original treatment.

Curettage and the use of bone chips was the procedure used in three cases. Ostectomy was done in one, resection and the massive graft in one, and simple resection in one. The results of surgery in this group of cases are known in all but one case. The only good result in this group was in the case of a lesion in the upper end of the fibula, in which resection was carried out eight years following irradiation. The results in all other cases were poor. In one patient, a malignant change developed in a lesion in the upper shaft of the humerus. The case history is as follows:

CASE No. 60, male, aged twenty-five, was first seen in 1935. At the age of nine years he had been struck on the right shoulder by another boy in an altercation. He had had some pain and soreness following this rather slight injury, which cleared up after a few days. He experienced no further discomfort whatsoever until about one year later when he fell on the ice and re-injured the right shoulder. Disability was great, and two weeks later from roentgenograms a physician made a diagnosis of bone sarcoma and advised immediate amputation. The patient's family refused this treatment. After consultation with other physicians, irradiation was instituted and he received thirteen treatments,—once a month for a period of about thirteen months. Treatment was then discontinued. He had considerable stiffness in his shoulder, however, which persisted, and still another physician was consulted.

He was then taken to another hospital where at the age of eleven years, after a diagnosis of bone cyst had been made, operative treatment was carried out. Roentgenograms of the original condition are not available, but, according to all reports from various physicians, the lesion was that of a simple bone cyst. Treatment consisted of irradiation for thirteen months, and curettage in 1923.

After the operation had been performed, the patient heard the arm break and felt sudden pain. Roentgenograms, taken after this accident, revealed a fracture, and the patient was advised that the arm would never heal. He took treatments for about one year, consisting of massage and active motion, which apparently caused a pseudarthrosis at the site of the fracture. He then went along without treatment until June 1934, during which time he had no symptoms. At that time, while he was lifting some heavy furniture, he felt a sharp sudden pain in the shoulder, and was forced to discontinue his work. He continued to have pain and swelling about the shoulder and lost considerable weight.

Examination on March 18, 1935, revealed marked emaciation of the individual, with gross shortening of the right arm. There was marked atrophy in the region of the upper humerus, and this humerus was at least four inches shorter than the other one. There was considerable soft-tissue swelling, and some induration about the shoulder joint. The skin was discolored, and very tough and thickened, apparently the result of irradiation.

Roentgenograms revealed a markedly shortened humerus, with complete absence of the upper third of the humeral shaft. A space was present between the old head of the humerus and the upper end of the lower fragment. The lesion of the head of the humerus

showed marked decalcification and irregular areas of bone absorption. There was marked bone destruction.

The diagnosis, made from aspiration biopsy, was spindle-cell osteogenic sarcoma. On March 25, 1935, an interscapulothoracic amputation was performed, which was followed by treatment with Coley's toxins.

The pathological report did not state the results of a gross examination, but microscopic sections showed spindle-cell osteogenic sarcoma.

In checking up on the further details of this case, a letter from the hospital at which the original operation was performed is interesting in this connection, and is as follows:

> "The patient was admitted to the Hospital January 18, 1923.
> *X-ray diagnosis:* simple bone cyst.
> *Operation:* excision and curettage of the cyst.
> *Pathology:*
>
> *Gross:* The curetted material from the bone lesion consists of spicules of bone, partly organized blood clot, bits of cartilage and strips of smooth white, shining membrane resembling synovial membrane. The appearance of the tissue does not suggest new growth.
>
> *Microscopic:* Several pieces of curetted material differing somewhat in appearance, but representative of all the curettings, were sectioned. Some show partly organized blood clot while others show chronic inflammatory tissue. Some of it is old dense fibrous tissue and some is quite recent soft and cellular containing new capillaries and granulation tissue. There is no evidence of neoplasm."

The original sections as described above are not available for examination, but it seems quite possible that this lesion was originally a simple benign bone cyst.

IRRADIATION COMBINED WITH SURGERY

Irradiation was used as a preoperative or postoperative measure in ten cases. It was given preoperatively in only one case, and a good result followed curettage and chemical cauterization, although a very small cavity remained at the site of the lesion. Irradiation was used as a postoperative measure following simple curettage in five cases. In one of these five cases recurrence of the lesion necessitated reoperation. This time, curettage and the use of the massive graft gave a good result. No further treatment was carried out in the other four cases, but in no one of these four cases was a perfect result obtained. The results, however, were considered to be fair to good from functional and anatomical standpoints. Irradiation was used postoperatively in two cases, following curettage and the use of the massive bone graft. In one, the result was excellent, and in the other, a failure. In one patient with a poor result from simple curettage, irradiation given two years later resulted in considerable improvement. In another, with a poor result from curettage and chemical cauterization, the same operation was repeated, followed by postoperative irradiation, and a good result was obtained. It is impossible to determine the exact rôle of irradiation in these cases, because the number is too small to warrant definite conclusions. The results in this group, however, are definitely no better than in those patients in whom surgery alone of one type or another was carried out.

AMPUTATION

Amputation was performed, for different reasons, on seven patients at some time in the course of treatment. For one patient, treated in 1911, a diagnosis of chondrosarcoma had been made by the pathologist, and a hip-joint amputation was done. Later study of the material on this case revealed that it was undoubtedly a benign lesion. The patient was well eighteen years following amputation. Amputation was performed on two patients despite the pathologist's report of a benign lesion, because the surgeon believed that the condition was malignant from the clinical behavior of the lesion some time after curettage had been done. Amputation was performed on one patient because of multiple refractures and non-union. In two other cases—one in the upper end of the humerus and the other in the upper shaft of the tibia—malignant changes developed thirteen and eight years later, respectively, following irradiation therapy. One of these patients died from metastases and the other was well three years following amputation.

RESECTION OR OSTECTOMY

Resection and replacement with a massive bone transplant, resection alone, or complete removal of the involved bone was carried out in eleven cases. Resection in cases involving the upper end of the fibula was performed in three cases with excellent results in all. Resection was performed in two cases involving the rib, with excellent results. Complete removal of the entire bone was carried out in three cases—a metatarsal, an astragalus, and a carpal navicular—with good results in each.

Resection with massive bone transplant was carried out in three cases. In two of these cases—the shaft of the radius and the shaft of the tibia—the results were excellent in every way. In one of these cases—the lower humerus—the result was not definitely known.

SIMPLE CURETTAGE ALONE

Simple curettage alone was the method of treatment in thirty-six cases. In this group no transplanted bone or chemical cauterization was used. Results in seven of these were excellent from every standpoint. Three others were excellent in every way except that the roentgenogram revealed a small residual cavity at the site of the lesion. One was excellent in every respect except that epiphyseal-growth arrest followed treatment. In four the anatomical and functional results were excellent, but no end-result roentgenograms were available for rating. Of six cases in which the results were unsatisfactory, three necessitated reoperation; one patient was later given irradiation, with improvement; and two amputations were performed because, in one, the lesion was believed to be malignant and, in the other, there were repeated fractures and non-union, with poor function. In four others the results were not good, but apparently no further treatment had been carried out. The results are unknown in nine of these and one is too recent for end-result rating.

SIMPLE CURETTAGE AND CHEMICAL CAUTERIZATION

Twenty-one cases were treated by curettage and cauterization with either zinc chloride or carbolic acid. Excellent results were obtained in six cases. In three the anatomical and functional results were excellent, but no end-result roentgenograms were available for examination. In three the anatomical and functional results were excellent, but the end-result roentgenograms revealed the presence of a small residual cavity at the site of the original lesion. In three others the results were somewhat short of excellent either because of anatomical disturbance, function, or roentgenographic appearance of the bone. The results were unknown in two, and it was too early for end-result rating in two. In two cases definite recurrence resulted and reoperation was performed at a later date.

In comparing the results from simple curettage alone and curettage combined with cauterization, it is very difficult to detect any particular advantage of one method over the other. The former group is larger, but the proportion of excellent results and recurrences is about the same for each. The amputations performed in the simple curettage group cannot necessarily be accredited to the method of treatment used.

CURETTAGE AND BONE CHIPS IN THE CAVITY AS A PRIMARY PROCEDURE

In nine of the cases, the cavity was thoroughly curetted and packed with bone chips taken from some other bone. The results were known in six, but in three it was too early to give an end-result rating.

Four of these cases were rated excellent in every respect. In two cases, the anatomical and roentgenographic results were excellent, but the functional results were graded down because of residual limitation of motion in the adjacent joint.

CURETTAGE AND BONE CHIPS IN THE CAVITY AS A SECONDARY PROCEDURE

Curettage and the use of transplanted bone chips in the cavity was used in eight cases in which some other method had already failed. Irradiation was the method originally used in four of these cases. The original method in the other four cases was as follows: curettage in one; autogenous blood injection in one; curettage and massive graft in one; and curettage and massive graft followed by irradiation in one.

The results of curettage and the use of bone chips were excellent in two cases. Poor results were obtained in two, and in one the anatomical and functional results were excellent, but the end-result roentgenogram revealed a small residual cavity. One case, originally treated by irradiation and later by bone chips in the cavity, proved to be due to a parathyroid adenoma. In two cases it was too early to determine the result. It is interesting to note in this group that the two excellent results from curettage and the use of bone chips in the cavity followed the use of either previous surgery or previous autogenous injection of blood. Most cases in which irradiation had originally been used gave poor results from surgery performed later.

CURETTAGE AND A MASSIVE GRAFT IN THE CAVITY AS A PRIMARY PROCEDURE

In thirteen cases the cavity was thoroughly curetted, and a massive bone transplant was placed in the cavity. In some cases the walls of the cavity were crushed, but in others they were not. Apparently, in no case was a combination of bone chips and a massive graft used. Eight of these cases were rated excellent in every way. One was excellent from the anatomical and functional standpoints, but the roentgenogram showed a small residual cavity. In another case the result was excellent, except that there was some residual stiffness of the joint. For one it is too early to give an end-result rating.

CURETTAGE AND THE MASSIVE GRAFT AS A SECONDARY PROCEDURE

Curettage and the use of a massive bone transplant in the cavity was used in three cases in which another method had given unsatisfactory results. Curettage was the other method in one, curettage combined with irradiation in the second, and irradiation alone in the third. The use of curettage and the massive graft gave excellent results in the cases which originally had curettage alone, or curettage combined with irradiation. A poor result was obtained in the case originally treated by irradiation.

LESIONS OF THE SKULL AND JAWS

Lesions of the skull and jaws occurred in eight cases, but the follow-up on these cases is too meager to justify any definite conclusions regarding them. These cases have therefore been excluded from any end-result calculation given in this paper, in order to prevent confusion in the end-result ratings from the various types of treatment.

SUMMARY

No excellent results were obtained in the group which had no treatment except for fracture when a fracture was present. Some of these patients improved considerably following fracture, but either deformity or a residual cavity was present as the end result in every case. No lesion in this group healed spontaneously with an excellent result.

Some patients treated by irradiation alone were definitely improved. Pain was relieved in almost all patients, when pain was present. Some patients were able to continue through life without any further treatment after the use of irradiation. In others, very little if any benefit was obtained. In a fairly large group of cases treated by irradiation, some form of surgery was resorted to later because of unsatisfactory results. There is definite evidence that surgery is less satisfactory when performed after irradiation has failed than it is when done alone. There is no evidence that preoperative or postoperative irradiation is of any benefit. Epiphyseal-growth arrest was fairly common in this group, and a malignant change took place in the bone in two cases many years after irradiation had been used. These two instances of malignant change were the only ones noted in this series.

Resection without replacement in unessential bones certainly seems to be the method of choice; this is especially true in the upper shaft of the fibula, and in the ribs. Resection and replacement with a massive bone graft, even in the essential weight-bearing bones, gave excellent results in a very small group of cases. This method of treatment may be more widely used in selected cases as surgical technique improves.

The results from simple curettage alone seem to be just as good as the results from curettage and chemical cauterization of the cavity. If cauterization is to be used, it would seem that thermal cauterization would be preferable because it can be more exactly controlled, and would not affect transplanted bone in the cavity.

In comparing the two groups of cases treated by curettage and the use of bone chips in the cavity on the one hand, and curettage with the use of a massive graft in the cavity on the other, there seems to be little choice between the two methods. The use of the massive graft in this group of cases, however, gave slightly better results than the use of multiple small chip grafts in the cavity. The combined use of the massive graft and multiple chip grafts in the cavity was not used in any case. It is possible that this method might yield better results than either of the others.

It is of interest to compare the surgical method in which no transplanted bone is used—such as simple curettage or curettage with cauterization of some form—with the method of cleaning out the cavity and transplanting either small chip grafts or the massive graft into the cavity. In the combined groups of curettage and curettage-cauterization, there are thirty-five cases, the end results of which are known. In the combined groups of bone chip and massive graft, there are twenty-eight cases in which the results are known.

Of the thirty-five cases treated by simple curettage or by curettage and cauterization, there were thirteen excellent results from every standpoint, and seven recurrences, which later required reoperation in six, and irradiation in one.

Of the twenty-eight cases in which bone chips or massive grafts were used, there were seventeen excellent results from every standpoint and only two required reoperation. The remaining results in each group were, in general, about the same.

From this study there can be no doubt that better results were obtained when transplanted bone was used in the cavity than when no bone was transplanted into the cavity.

The results of this study seem to narrow the choice of treatment in operable cases down to two methods,—that is, resection, or the use of transplanted bone after thorough cleaning out of the cavity. Irradiation should be reserved for use in inoperable cases, and should then be used only under the strictest precautions, as definite harm may result from its use.

Since most of the cases are seen in childhood, and almost all of them

are operable, it is clear that no one method of treatment could be classed as the best method to use in every case. It has been shown that poor results may follow the use of any method that has been used up to this time, except resection. In the non-essential bones, such as the shaft of the fibula and the ribs, resection is the method of choice, routinely. In growing children when the lesions are near the epiphyseal line, especially in the essential weight-bearing bones, resection is not adaptable. In these cases, thorough unroofing of the cavity, curettage, and the use of transplanted bone would seem to be the method of choice. In cases of long standing where the lesion has grown away from the epiphysis, resection and replacement by a massive bone transplant should probably be used more often.

INTERCALARY BONES OF THE INTERVERTEBRAL DISC

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The "intercalary bones" (ossicula intercalaria, Schaltknochen) of the intervertebral disc are irregularly shaped, isolated osseous formations interposed between two vertebrae, and are usually found in the anterior peripheral portion of the intervertebral disc. They occur in older individuals who suffer from spondylosis, and are found mainly in the discs of the lumbar portion, although they are occasionally encountered in the thoracic and cervical portions of the spinal column. To convey an idea of the actual appearance of these formations, the author refers the reader to the photographs of pathological preparations illustrating the articles by Niedner and Schmorl.

On roentgenographic examination, the postero-anterior view reveals irregularly outlined, smaller or larger shadows in the intervertebral space, in the neighborhood of the vertebral corner. These spots are easily identified, if they are situated between two opposite spondylotic osteophytes. The lateral view shows them as homogeneous, triangular shadows, the size of a rice kernel or even larger, situated in the anterior portion of the intervertebral space between the upper and lower edges of two adjacent bodies. They sometimes touch the edge of the vertebral body, and may approach two opposite spondylotic osteophytes; however, an open space appears between these shadows and the vertebral surface. The presence of these formations is characteristic of spondylosis.

The occurrence of spondylotic osteophytes is closely associated with changes taking place in the anterior portion of the annulus fibrosus of the intervertebral disc, the annulus of the vertebral epiphysis, the fibers of which are firmly attached to the bone tissue. The fibers are very tough and include transverse bands of so-called "tension-fibers". As a consequence of the strain imposed upon the spinal column during the course of life, a number of fissures and gaps may occur in the annulus fibrosus. The solid structure of the outer portion of the annulus fibrosus is loosened, and the connection between the annulus and the osseous epiphysis of the vertebral body is frequently disrupted. Every movement causes the anterior portion of the intervertebral disc to be pushed toward the anterior longitudinal ligament, in this way giving rise to osteophyte formation at the insertion of the ligament on the vertebral body. Schmorl believed that the injured tissue of the annulus fibrosus, or even that of the nucleus pulposus, is pushed into the fibers which are split longitudinally, and there—at a later stage—becomes subject to calcification, and is eventually converted into an "intercalary bone".

In Schmorl's posthumous paper (1932), the opinion is expressed that intercalary bones usually develop from foci of calcification, which are not infrequently encountered in the anterior portions of the annuli fibrosi of the intervertebral disc in spondylosis.

Niedner (1933) stresses the fact that the prerequisite condition for the formation of these bones—apart from fissures and gaps in the peripheral portion of the annulus fibrosus—is the presence of serious lesions, such as necrosis of these areas of the intervertebral disc. It is into these parts of the intervertebral disc, through gaps produced by tearing the epiphysis from the vertebral body, that tissue, containing vascular buds and bone-producing elements, penetrates. From this penetrating tissue, the intercalary bone develops. Spondylosis, as well as the production of intercalary bones, is possible only if the annulus fibrosus is torn away from the epiphysis of the vertebral body.

In contradistinction to a posterior herniation of the intervertebral disc—which causes bulging of the posterior longitudinal ligament, and may extend into the spinal canal—the ossicula intercalaria of the intervertebral disc may be considered as harmless spondylotic formations encountered as a rare, accessory finding in the rather frequently occurring spondylosis. This is illustrated by the following case history:

The patient, aged fifty-eight, had been suffering from recurring lumbago for some time and the pain had become more marked after he had fallen down stairs, landing on his back, three weeks before the roentgenogram was taken. The spinal column showed no evidence of pathological changes and was freely movable in any direction. Apart from spondylotic spicules, seen in the thoracic and lumbar portions of the vertebral column, the postero-anterior roentgenogram showed nothing of significance.

In the lateral view (Fig. 1), however, there are spurlike osteophytes at the anterior edges of the adjacent third, fourth, and fifth lumbar vertebral bodies. In the most anterior portion of the intervertebral space between the bodies of the fourth and fifth lumbar vertebrae, a large, homogeneous triangular shadow is visible, its density corresponding to that of the osseous tissue. This piece of bone, taking up almost the entire height of the intervertebral space, is definitely separated from the vertebral surface by intervertebral tissue. The edges of the vertebral bodies situated opposite these bone fragments are normal in appearance. Between the anterior corners of the third and fourth lumbar vertebral bodies some spots are visible, which, however, cannot be definitely identified as intercalary bones, and which may have some connection with osteophyte formation.

FIG. 1

Lateral roentgenogram of a man, aged fifty-eight, showing an intercalary bone of the intervertebral disc between the fourth and fifth lumbar vertebrae.

In this case it can easily be imagined how the intercalary bone has been produced in that part of the disc which has been pushed forward. The production of the intercalary bone must necessarily have preceded that of the osteophyte,

since the latter has adjusted itself in shape and outline to the larger intercalary bone. This is also contradictory to the assumption that the intercalary bone might have developed as a result of an accident, occurring only three weeks previously. Consequently, in this case, any claim for compensation had to be rejected.

The intercalary bone represents the ultimate stage of a curative process in a lesion, which had occurred a considerable time previously, in the outer portion of the annulus fibrosus of the intervertebral disc. It is, however, not always possible to ascertain whether these osseous formations are genuine intercalary bones or detached spondylotic osteophytes. In Figure 2 there is apparently an intercalary bone between the sixth and seventh cervical vetebrae of a woman, aged fifty-nine. However, it is also possible that, in the manner described previously, an osteophyte may have developed into an intercalary bone. Both formations, in any event, are of spondylotic nature.

FIG. 2

Lateral roentgenogram of a woman, aged fifty-nine, showing an intercalary bone between the sixth and seventh cervical vertebrae (*arrow*), and calcification of the anterior longitudinal ligament (*0*).

DIFFERENTIAL DIAGNOSIS

Very rarely calcification and ossification of the nucleus pulposus of the intervertebral disc are also encountered in connection with spondylosis. In these cases, the fissures in the fibrous structure of the annulus fibrosus have extended up to the wall of the nuclear cavity, and thus permit a part of the nucleus material to escape. This severely interferes with the function of the nucleus pulposus and the entire intervertebral disc. The nucleus pulposus may become subject to calcification; it may also show vascularization originating from the gaps in the vertebral epiphysis; and it may eventually become ossified. This process of calcification and ossification of the nucleus pulposus is similar in nature to the formation of intercalary bones in the anterior part of the intervertebral disc.

In a woman of fifty-nine, who suffered from severe back pain from time to time, the spinal column showed no changes in its outward appearance, although there was some limitation of movement in all directions. In the intervertebral space between the seventh and eighth thoracic vertebrae, as shown in the roentgenogram (Fig. 3-A), there are, particularly in the area of the nucleus pulposus, a number of intense linear

shadows. From the region of the lower right edge of the seventh thoracic vertebra, an osteophyte runs in a curved line in an outward-downward direction, touching upon an osteophyte of the upper outline of the eighth thoracic vertebra. Intermingled with this are seen several fine bands of calcific shadows.

In the lateral view (Fig. 3-B), the roentgenogram reveals the calcific shadows in the center of the intervertebral space to be horizontal bands. In this view the thickening of the anterior edges of the seventh and eighth thoracic vertebrae is also evident. The other vertebrae, too, show small osteophytes at their anterior edges. The calcification and ossification of the nucleus pulposus, seen in the postero-anterior view, appears in the lateral one as a central shadow in the intervertebral space. The roentgenographic appearance changes in accordance with the varying shape of the nucleus pulposus and, moreover, in accordance with the direction from which the roentgenogram is taken. The spots of calcification and ossification are seen as cloudy, patchy shadows,—sometimes arranged like the skin of an onion, depending upon the presence of lime depositions in the fissures and villi of the cavity within the nucleus pulposus which von Luschka first described, and sometimes filling the entire cavity. Clinical differentiation between calcification and ossification, as indicated by Schmorl, is not always possible from

FIG. 3-A

FIG. 3-B

Postero-anterior and lateral roentgenograms of a woman, aged fifty-nine, showing calcification and ossification of the nucleus pulposus of the intervertebral disc between the seventh and eighth thoracic vertebrae.

the roentgenographic appearance. The intercalary bone, however, either does not appear at all in the postero-anterior view (where it may be overshadowed by osteophytes), or represents an isolated central patch of ossification between two lateral osteophytes. In the lateral view, the intercalary bone appears between the thickened portions of the opposite edges of two vertebral bodies as an isolated triangular shadow in the intervertebral space, with the same degree of density as is found in the spongiosa of the vertebral body.

Intercalary bones, as well as calcification and ossification of the nucleus pulposus in the intervertebral disc in spondylosis, have nothing in common with the calcified foci in the nucleus pulposus, which are met with in juveniles as a sequel to infectious diseases. Since the vertebral disc remains vascularized up to the age of twenty-five years, calcification, as a consequence of metastatic infection of the intervertebral disc, may be possible up to that age; but in the higher-age groups degenerative changes, such as calcification of the nucleus pulposus, have to be considered.

Metastatic inflammation as the exciting factor in the production of calcification in the center of the intervertebral disc between the sixth and seventh thoracic vertebrae was found in a boy, eight years of age (Figs. 4-A and 4-B). He had had a temperature for two days, following which he could not freely move his head and right arm. He had had pain in the right arm and in the neck, which had disappeared after a fortnight. In the lateral view (Fig. 4-A) taken on November 23, 1931, a shadow, the size of a bean, is seen in the area of the nucleus pulposus between the sixth and seventh cervical vertebrae. In the postero-anterior roentgenogram taken on April 4, 1932 (Fig. 4-B), there is still another shadow in the mid-line and two smaller ones in its neighborhood. After eight months the calcified patches of the intervertebral disc had completely disappeared.

Disappearance of the calcified foci in the area of the nucleus pulposus of the intervertebral disc is a feature characteristic of the metastatic type developing in early childhood. However, retrogressive changes of the type of degenerative calcification usually encountered in older persons, are extraordinarily rare, and ossification of the nucleus pulposus or intercalary bones has never been observed.

A triangular shadow which may appear at the anterior upper edge of one of the lumbar vertebrae, produced by the intrusion of the tissue of the intervertebral disc into the spongiosa of the vertebral body, provides scarcely any difficulty in the differential diagnosis. In the outermost portion of the annulus fibrosus, calcium shadows are not infrequently found, which are impossible to distinguish from intercalary bones; only when the calcification of the annulus fibrosus has reached a certain proportion can it be revealed by roentgenograms in the living organism. In the lateral view, the calcium shadows appear as lines or small dots in the intervertebral spaces. Güntz is certainly wrong in believing that in the presence of spondylosis the formation of intercalary bones is more prob-

able than is the simple deposition of calcium in the area of the annulus fibrosus. In certain individuals extraordinary tension and strain imposed on the anterior portion of the intervertebral disc stimulate the deposition of calcium salts there, and this is particularly so in the case of spondylosis. This is also in accordance with Schmorl's view that intercalary bones develop from foci of calcification in the pathologically changed anterior portion of the annulus fibrosus in spondylosis.

FIG. 4-A

FIG. 4-B

Fig. 4-A: November 23, 1931. Lateral roentgenogram of a boy, aged eight, showing calcification of the nucleus pulposus of the intervertebral disc between the sixth and seventh cervical vertebrae.
Fig. 4-B: April 14, 1932. Anteroposterior view.

By exposure to increased tension, small foci of calcification or ossification may also develop in the anterior longitudinal ligament (Fig. 2, *o*), and may produce lateral roentgenographic appearances very similar to those of intercalary bones. However, considerable calcification of the anterior longitudinal ligament in the lumbar portion of the spinal column may produce arches which sometimes extend to a considerable height at the vertebral body; roentgenograms of this type are not easily mistaken for intercalary bones. An osteophyte, characteristic of spondylosis, may be partly or completely detached from the tissue of the intervertebral disc which has penetrated it, and may even break off. If such an osteophyte happens to protrude far in an outward direction, it may produce a roentgenographic appearance similar to that of an intercalary bone.

SUMMARY

1. The intercalary bone of the intervertebral disc is an osseous formation completely surrounded by the tissue of the intervertebral disc,—that is, it is interposed between the two intervertebral bodies.

2. Considering the high incidence of spondylosis, these formations provide a rare accidental finding of only secondary importance.

3. Symptoms, if any are present, are not characteristic of the condition; particular symptoms definitely connected with the presence of intercalary bones do not exist. The intercalary bones do not occur as a sequel to an accident. Intercalary bones, as well as calcification and ossification of the nucleus pulposus, are encountered in connection with spondylosis, providing that a certain degree of wear and tear of the intervertebral disc has occurred. They represent the ultimate stage of a curative process in a lesion of the outer portion of the intervertebral disc and of the nucleus pulposus, which had occurred a considerable time before.

REFERENCES

GÜNTZ, EDUARD: Schmerzen und Leistungsstörungen bei Erkrankungen der Wirbelsäule. Stuttgart, Ferdinand Enke, 1937.

LYON, ERNST: Kalkablagerungen in der Zwischenwirbelscheibe im Kindesalter. Ztschr. f. Kinderheilk., LIII, 570, 1932.

Spondylosis deformans und Arthrosis deformans der kleinen Wirbelgelenke. Schweizerische Med. Wchnschr., LXVII, 209, 1937.

On the Displacement of the Intervertebral Discs, Rarely Known Hitherto, and Its Consequences. Folia Clinica Orientalia, I, 225, 1937.

NIEDNER, FRANZ: Schaltknochen in den Zwischenwirbelscheiben. Fortschr. a. d. Geb. d. Röntgenstrahlen, XLVII, 70, 1933.

SCHMORL, GEORG: Über Verlagerung von Bandscheibengewebe und ihre Folgen. Arch. f. Klin. Chir., CLXXII, 240, 1932.

AN ARTHROPLASTY FOR CONGENITAL DISLOCATION OF THE HIP *

A Late Follow-Up Report

BY PAUL C. COLONNA, M.D., PHILADELPHIA, PENNSYLVANIA

In June of 1929 at Bellevue Hospital, New York City, a boy of seven with bilateral, congenital dislocation of the hip was treated by the author. An open operation was performed without any preliminary traction. With a great deal of effort, the right hip was reduced, and, although the head was finally placed in the old acetabulum "by main strength and awkwardness", a marked limitation of motion developed, and subsequent roentgenograms showed fragmentation of the head and a severe grade of traumatic arthritis. This unsatisfactory result of an open reduction at this age impressed the author strongly. The result was attributed to several factors,—among them the necessity for a preliminary stretching of the soft tissues, the danger of an excessive degree of trauma at the time of the reduction, and the fact that a deficient acetabulum always makes reduction difficult and retention hazardous. Therefore, before attempting to reduce the opposite hip the next year, this child received a long period of preliminary traction. In June of 1930 an open operation was performed on the left hip using, for the first time, the procedure to be reported.

OBSERVATIONS ON THE PATHOLOGICAL PICTURE

In all congenital dislocations of the hip, the roentgenograms are, of course, of great aid in evaluating the malformations which may be present in the head and acetabulum, particularly the shallowness of the latter; and these factors are recognized as being of prime importance in the permanency of any reduction. However, because attention has so often been centered upon the bony elements in this deformity, the important rôle which the soft tissues play in preventing true reduction has not always been visualized. Of these structures, the capsule occupies a rôle of the utmost importance. Under the stresses and strains of weight-bearing, the head, in the great majority of cases, assumes an upward and posterior position in relation to the poorly formed acetabulum, and, as the head travels upward and backward, the hour-glass type of capsule develops. This means that the isthmuslike portion of the attenuated capsule may be of varying length and diameter, depending upon the location of the capsule-covered head, because the change in shape of the capsule in the dislocated hip will be dependent upon the stresses and strains of weight-bearing. Therefore, the capsule will be found to be thickened over the

* Read at the New York Academy of Medicine before the Section on Orthopaedic Surgery, April 17, 1942.

superior cartilage of the head where a great portion of the weight is borne.

Also the pelvitrochanteric group of muscles, as well as the larger blood vessels and nerves, all become contracted because of the backward and upward displacement of the head, and, because of this shortening, render reduction difficult. Therefore, a preliminary stretching is usually necessary before reduction should be attempted. Whenever the head is posterior to the sagittal plane of the pelvis, lordosis is bound to be a constantly deforming element; and, until this backward and upward displacement is corrected, both the lurch and the lordosis will persist. This the arthroplasty operation attempts to do. This two-stage procedure was first described in *The Journal of Bone and Joint Surgery* in April, 1932.

INDICATIONS FOR THE PROCEDURE

The procedure advocated has been found most useful in two types of cases; first, in patients under three years of age whose hips have been satisfactorily reduced by closed manipulation, but, in spite of careful care, have not remained reduced. The percentage of failures following closed manipulation will vary widely, depending upon the clinic reporting any large number of follow-up cases. A conservative estimate of redislocations within this age group would probably be somewhere around 25 per cent. The second group of cases includes patients over three years of age and under ten. It is felt that open operation is the method of choice in any case of congenital dislocation in a child between three and five years of age, but that in a patient over five years of age, closed reduction should not be attempted.

The age of the patient is the factor largely determining the type of procedure to be employed in treating congenital dislocation of the hip. In children *over* ten with unilateral dislocations, and *over* seven with bilateral, a reconstruction of the acetabulum as described by Gill is preferred. At times, however, it is believed that an arthrodesis, as recommended recently by Frankel, may be advisable in certain unilateral cases. The arthroplasty advocated has been performed on a few patients who were about twelve years of age, and, although stability has been obtained, there has been an aseptic necrosis of the head with increased stiffness of the hip. It is, therefore, felt that there is a definite age limitation to the operation described in this paper.

THE PROCEDURE ADVOCATED

First Stage

Twenty-four hours before any preliminary stretching is done, moleskin adhesive straps are applied to the affected limb. These straps extend to within a few inches of the tip of the greater trochanter laterally and to the groin medially. The following day, after the moleskin has attached itself to the skin, the dislocated hip is thoroughly stretched under anaesthesia, and the adductor muscles are subcutaneously tenotomized. No attempt is made to reduce the dislocation at this time. A long, plaster

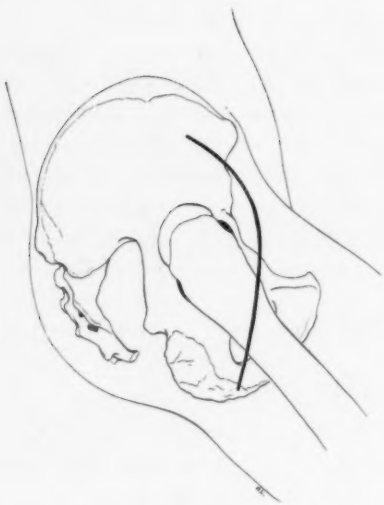

FIG. 1-A

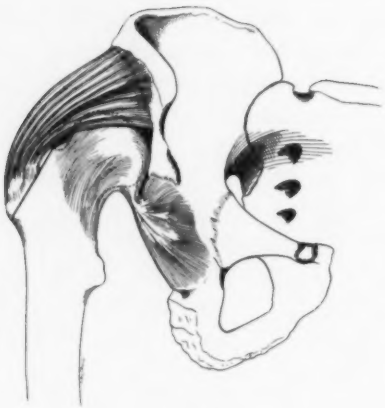

FIG 1-B

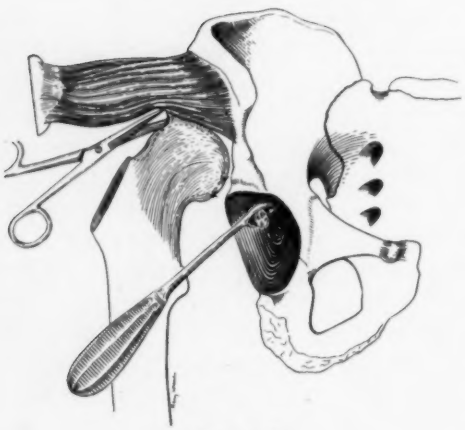

FIG. 1-C

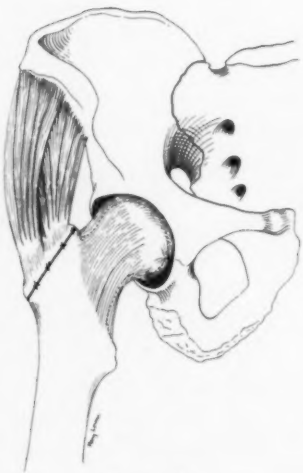

FIG. 1-D

Fig. 1-A: Skin incision.

Fig. 1-B: Diagrammatic view of the hour-glass appearance of the capsule. Drawing shows how the greater trochanter is chiseled through.

Fig. 1-C: The greater trochanter with its attached muscles is retracted upward and the capsule is easily separated from the surrounding structures and followed down to its isthmus. The capsule is then cut across, and by several sutures is made into a sac covering the head. With a Doyen reamer or large curette, a smooth, capacious acetabulum is made at the site of the original acetabulum.

Fig. 1-D: The head with its synovial-lined capsule is then placed deep in the newly formed acetabulum; the greater trochanter is replaced and held with several kangaroo sutures; and the wound is closed in layers. A long plaster spica is then applied with the limb in 15 to 20 degrees of abduction. (*Reproduced by courtesy of Surgery, Gynecology and Obstetrics.*)

spica is then applied to the opposite side, and ten to fifteen pounds of skin traction is immediately applied to the dislocated side. In some instances skeletal traction has been used. The weight is increased gradually over a

period of two or three weeks, and roentgenograms are taken with and without traction to determine the actual stretching of the soft tissues. This preliminary traction period, which is the first stage, may require several or more weeks. Until the soft structures about the hip have been mobilized sufficiently to bring the head down approximately opposite the level of the old acetabulum, the second stage (open operation) of the procedure *should not be attempted*, and this position can be accurately determined only by roentgenogram. Individual cases may vary considerably in the degree of telescoping possible and in the amount of relaxation that can be obtained by preliminary traction. Therefore, in some of the very young patients with marked relaxation it has not been found necessary to employ preliminary traction. When the maximum amount of stretching has been obtained, the plaster spica is bivalved, and the hip region is prepared in the usual manner, disturbing as little as necessary the moleskin straps. The patient is sent to the operating room with the traction intact.

Second Stage

A skin incision is made, beginning about two inches behind the anterior superior spine, and curving downward and then backward, to a point about two inches below the tip of the greater trochanter. The fascia is then divided by a curved incision paralleling the skin incision. The rectus femoris tendon at its origin on the anterior inferior spine is identified and is divided, sometimes by zig-zag tenotomy. The greater trochanter, with its attached muscles, is chisled through, and is turned upward, and the capsule is easily separated from the surrounding structures by scissors dissection. When the isthmus of the capsule is reached, it is divided, and the head of the bone is inspected, as to its shape and appearance, and the presence or absence of the ligamentum teres. Any remodeling of the head is to be strongly condemned, for there is evidence to believe that the contour of the head will have a tendency to approach its normal shape if the cartilage is left intact. The opening in the capsule is then closed with several chromic sutures. With reamers or curette, a capacious acetabulum is formed as near its original site as preliminary traction has made possible. No skid or unusual force should ever be necessary to reduce the head into the reamed-out acetabulum if the preliminary period of traction has been adequate, for the capsule-covered head must be placed gently into the deepened and reamed-out acetabulum to give the best opportunity for free movement later. The greater trochanter is then sutured back into place, and the wound is closed in layers. A long plaster spica, incorporating the traction straps in the plaster, is then applied while the limb is held in about 20 degrees of abduction and complete extension.

POSTOPERATIVE CARE

The convalescent care in these cases is a very important step in preserving stability and mobility. The original plaster spica is worn for four

RIGHT LEFT

FIG. 2-A

Case 1. P. S. On admission.

RIGHT LEFT

FIG. 2-B

May 3, 1930. Before operation on the left hip. The right hip had been reduced without any preliminary traction and without the preservation of the capsule over the head of the bone. At present the right hip is stiff.

RIGHT LEFT

FIG. 2-C

May 21, 1935. Five years after operation on the left hip. The arthroplasty operation was done only on the left side, and there is at present stability and a good range of mobility.

weeks after operation, although two weeks after operation the posterior portion covering the foot and leg is removed at intervals during the day, and the patient actively moves the foot and knee. Four weeks after the operative stage the plaster spica is completely removed; and a posterior shell, extending from the groin to the toes, is prepared; so that, by means of an overhead suspension bar, active and passive movement at the hip can be begun. Care is taken to keep the limb slightly abducted at all times, and this is most easily accomplished by placing a small pillow between the legs. If a therapeutic pool is available, it is an advantage to have the patient begin under-water exercises at about this time.

During the convalescent period, the hip must be carefully watched for evidences of adductor muscle spasm; and, if this develops, no attempt should be made to force motion for a few weeks. Traction and rest to the limb will usually suffice to overcome this tendency, and active motion can be started again.

It must be remembered that a considerable degree of accommodative change must take place within the first few months following a procedure of this sort. After the capsule has been reduced into the reconstructed acetabulum, a firm union between the capsule and the bony walls of the new

FIG. 3-A

Case 2. B. A. September 5, 1935. Before operation on the right hip.

FIG. 3-B

January 17, 1942. More than six years after the arthroplasty, the patient presents a practically normal range of movement.

FIG. 4-A

Case 3. D. R. January 25, 1935. Before operation on the right hip.

FIG. 4-B

January 17, 1942. Seven years after operation. The patient has a stable hip, an excellent range of motion in all directions, and no shortening. She walks without a limp.

FIG. 5-A

Case 4. D. K. September 26, 1933. Before operation on the left hip.

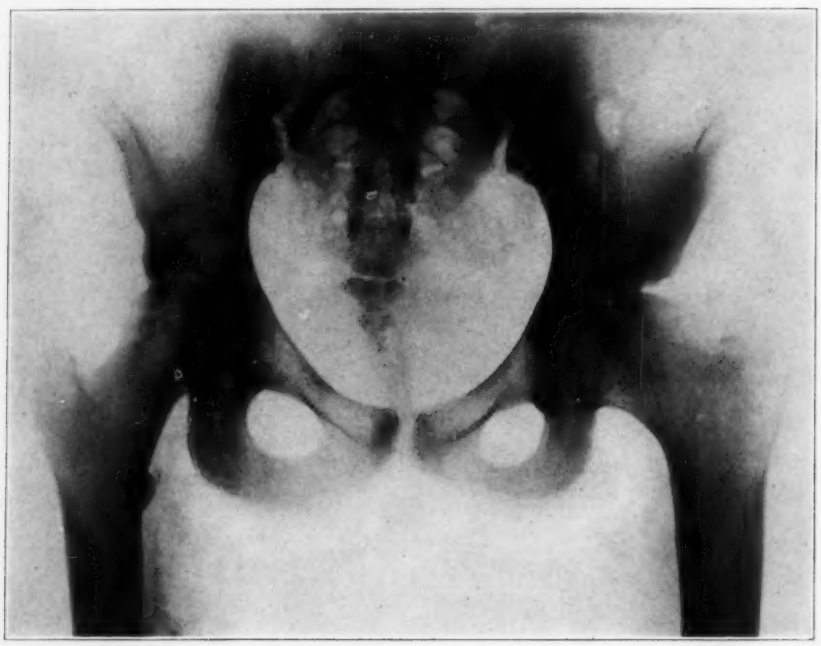

FIG. 5-B

January 17, 1942. Eight years after operation. The patient has a stable hip with an excellent range of motion and walks without a limp. Note the normal joint space and the restoration of the normal contour to the head of the femur.

acetabulum must develop, and from roentgenograms of patients taken many years after operation, it must be assumed that the lining of this reconstructed acetabulum closely resembles the normal articular cartilage.

No weight-bearing is allowed for at least three months after the second-stage procedure, and in some instances it has been found useful to fit the patient with a Thomas ring knee splint and to elevate the opposite shoe in order to relieve the hip from full weight-bearing for a few months longer.

END RESULTS

In selected cases, the method described is felt to offer an opportunity for accomplishing several objectives. First, it corrects the backward and upward displacement of the head and, therefore, the lordosis and lurch of the body on weight-bearing. The operation also lessens, or completely overcomes, the shortening of the affected extremity; and it secures stability and mobility to the congenitally dislocated and unstable hip.

The author has wanted to know for some time what ultimately happens to these hips. The first patient was treated by this procedure in 1930, but was lost track of after a five-year follow-up. When the patient was last seen the result could be classed as quite satisfactory both functionally and roentgenographically (Fig. 2-C).

Five other patients who were operated upon a few years after this first patient can now be reviewed. In two, the follow-up has been over nine years; in two, over seven; and in one, about six and one-half years. In 1936, when these five cases were reported, it was stated, "the time of follow-up with the procedure advocated is insufficient to draw any definite conclusions as to what will be the ultimate functional and roentgenographic appearance of these hips". It can now be said that the functional results in these five patients are quite satisfactory. They walk today with hardly a limp, and present an excellent range of motion in all directions.

From the roentgenographic standpoint, a review of these cases has been particularly interesting, and the following facts can be demonstrated from the recent roentgenograms:

1. The depth of the reamed-out acetabulum has remained unchanged or, in some cases, has become apparently deepened after years of weight-bearing.

2. An increased density of the roof of the acetabulum has been a frequent observation in this follow-up study.

3. It may be noted that the time of fusion of the acetabular floor has been hastened.

4. Aseptic necrosis has not developed in the head of the femur in any of these cases. This is particularly interesting when it is remembered that the ligamentum teres, when present, is removed in all cases, to allow

the capsule to be sutured as a sac over the femoral head during the second stage of the operation.

FIG. 6-A

Case 5. P. Z. December 2, 1932. Before operation on the right hip and at the end of the first stage, showing that the head has been pulled down opposite the old acetabulum. This is a prerequisite to open operation.

5. There has been no diminution of the joint space postoperatively, when the patient has been operated upon within the age limits previously defined.

6. The roentgenographic development of the upper femoral epiphyses has been uniform, and, in some instances, a normal contour has developed following operation in an epiphysis preoperatively deformed.

7. There have been no redislocations, and the stability of the hip has been assured.

8. There has been very little, if any, posttraumatic arthritis noted in any of these patients, two of whom were operated upon more than nine years ago.

FIG. 6-B

April 15, 1936.

CASE REPORTS

CASE 1. P. S., a boy, seven years of age, was admitted to the Orthopaedic Service at Bellevue Hospital, New York City, in June 1929. He presented the characteristic features of congenital dislocation of both hips (Fig. 2-A).

On December 19, 1929, the right hip was operated upon without preliminary traction, and the dislocation was reduced with difficulty. The head was forced into a reamed-out acetabulum with a skid. The result proved unsatisfactory, and the hip has become increasingly stiff. As shown in the roentgenograms, the bony proliferation about the joint has increased since the operation.

On June 1, 1930, the procedure here advocated was performed on the left hip. The structures were stretched, the adductors were tenotomized, and heavy skin traction was applied, as described in the first stage of the treatment. On June 16, 1930, the second stage was completed.

In roentgenograms taken five years after operation on the left hip (Fig. 2-C) a definite joint space appears to have developed. This joint presented about 80 degrees of voluntary flexion from complete extension. The Trendelenburg sign is negative on the left side.

CASE 2. B. A., a girl of three years and ten months, was admitted to the Hospital for the Ruptured and Crippled (now the Hospital for Special Surgery) in October, 1935. This child had previously had two unsuccessful attempts at closed reduction of the right hip. She had a shallow acetabulum and deficient roof, so that further attempts at closed reduction were not thought advisable. On admission the child was in good general condition, but had the characteristic limp on walking, and a positive Trendelenburg sign.

FIG. 6-C

January 17, 1942. Nine years after open operation. The hip is stable and presents a normal range of motion. The epiphysis is well developed and there is no perceptible limp.

FIG. 7-B

May 2, 1933. At the end of the first stage.

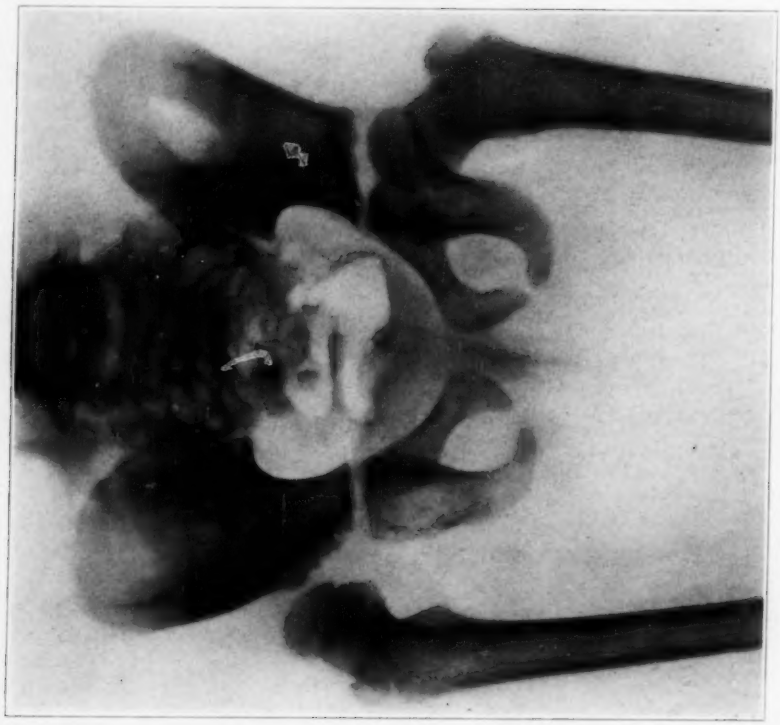

FIG. 7-A

Case 6. A. Y. April 24, 1933. Before operation on the right hip.

FIG. 7-C

January 17, 1942. Nine years after operation. Patient presents no shortening, has a complete range of movement, and walks without a limp. Roentgenogram shows normal development of the head and normal joint space.

On October 1, 1935, the first stage of treatment was begun, and on October 25, 1935, the second stage.

At present she walks with only a slight limp. The Trendelenburg sign is negative and she has a normal range of motion. Roentgenogram (Fig. 3-B) shows the appearance of the hip six and one-half years after operation.

CASE 3. D. R., a girl of three, was seen at the Hospital for the Ruptured and Crippled in January 1935. This patient originally had been under treatment at this Hospital for bilateral congenital dislocation. Six months previously the right congenital dislocation had been reduced by closed manipulation, but had redislocated (Fig. 4-A).

The child presented a rather insecure left hip and a frankly dislocated right hip. There was the characteristic limp on the right, and a shortening of one-half inch. Open operation was advised.

No preliminary traction was necessary in this case, and on February 13, 1935, the operation on the right hip was performed.

At present the child has no shortening, and the Trendelenburg sign is negative on both sides. She is very active and has a good range of movement of the right hip in all directions (Fig. 4-B).

CASE 4. D. K., a girl of four and one-half years, was admitted to the Hospital for the Ruptured and Crippled in December 1933, with a congenital dislocation of the left hip. She had had three previous attempts at closed reduction, and each time the dislocation had recurred on removal of the plaster (Fig. 5-A).

On admission the child was in good general condition, but had a marked limp and a positive Trendelenburg sign. There was one-half inch of shortening.

On January 3, 1934, the first stage of treatment was begun and on January 15, 1934, the second stage.

At present the child walks with a limp, but there is no shortening and she has a normal range of motion (Fig. 5-B). The Trendelenburg sign is negative.

CASE 5. P. Z., a girl of four and one-half years, was admitted to the Hospital for the Ruptured and Crippled in November 1932, with a congenital dislocation of the right hip. This patient had never had any previous treatment for the dislocation, and presented the characteristic findings of a unilateral dislocation. There was one-half inch of shortening and a positive Trendelenburg sign.

On November 21, 1932, the first stage of treatment was begun, and on December 5, 1932, the second stage. Figure 6-A shows the condition at the end of the first stage of treatment, and Figure 6-B over three years after operation.

At present the child walks without a limp. The Trendelenburg sign is negative and she has a normal range of movement. Attention is called to the width of the joint space, and the size and apparent smoothness of the outline of the epiphysis years after the operation. Roentgenogram (Fig. 6-C) shows the appearance of the hip nine years after the operation.

CASE 6. A. Y., a girl of six, was admitted to the Orthopaedic Service of Bellevue Hospital in April 1933, with a congenital dislocation of the right hip (Fig. 7-A). When the child was an infant several attempts had been made to reduce the dislocation, but none had been successful. On admission she was in good general condition, but had the gait characteristic of a dislocation of the right hip. The Trendelenburg sign was positive, and there was shortening of three-quarters of an inch.

On April 20, 1933, the first stage of treatment was begun, and on May 5, 1933, the second stage. Figure 7-B shows the condition at the end of the first stage of treatment.

At present the child walks without a perceptible limp. There is no shortening and she has an almost normal range of movement in all directions. The Trendelenburg sign is negative. Roentgenogram (Fig. 7-C) shows the appearance of the hip nine years after the operation.

The above cases were reported by the author in an article published in *Surgery, Gynecology and Obstetrics* (LXIII, 777, 1936), with the results at that time. Material and illustrations from that article are reproduced by courtesy of *Surgery, Gynecology and Obstetrics*.

REFERENCES

COLONNA, P. C.: Congenital Dislocation of the Hip in Older Subjects. Based on a Study of Sixty-Six Open Operations. J. Bone and Joint Surg., XIV, 277, Apr. 1932.

An Arthroplastic Operation for Congenital Dislocation of the Hip—A Two Stage Procedure. Surg. Gynec. Obstet., LXIII, 777, 1936.

FRANKEL, C. J.: Palliative Treatment of Irreducible Congenital Dislocations of the Hip. Southern Med. J., XXXV, 404, Apr. 1942.

GILL, A. B.: Operation for Old Congenital Dislocation of the Hip. Surg. Clin. North America, VI, 147, 1926.

Plastic Construction of an Acetabulum in Congenital Dislocation of the Hip—The Shelf Operation. J. Bone and Joint Surg., XVII, 48, Jan. 1935.

RHIZOMELIC SPONDYLOSIS

Orthopaedic and Roentgen Therapy

BY LENOX D. BAKER, M.D., DURHAM, NORTH CAROLINA

This preliminary report describes the apparatus and routine used in twenty-two cases of rhizomelic spondylosis treated by roentgenotherapy combined with well-established orthopaedic measures. The therapy has been directed at alleviating pain, relaxing muscle spasm, and correcting deformities, with the hope of arresting the disease.

In his report on the end-result study of 106 cases of ankylosing spondylitis, Swaim reviewed the course that the disease usually takes, and pointed out that muscle spasm exists for some years before actual ossification of the ligaments takes place. He stated that, in his experience, orthopaedic treatment should begin as early as possible, but that much could be done up to nine years. His therapy consists of gradual hyperextension of the spine, relaxation of muscles, corrective exercises to straighten the spine and increase chest expansion, and immobilization of the spine to hold the correction. Swaim believes that the trauma of use plus continued muscle spasm serves to keep the disease active, and to keep the involved tissues in an inflamed condition during convalescence. He uses plaster-of-Paris or leather body jackets to obtain complete immobilization, which he does not believe is accomplished by the popular type spinal braces. The principles of Swaim's therapy are used to treat patients admitted to the Orthopaedic Service at Duke Hospital with a diagnosis of Marie-Strümpell disease. In a majority of the patients severe pain is usually present during the early period of treatment. The addition of roentgenotherapy gives early alleviation of pain with relief of

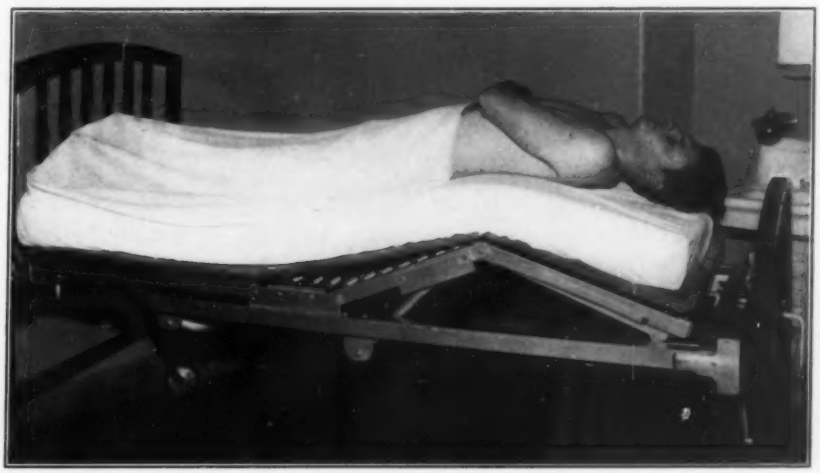

Fig. 1

muscle spasm, and it allows rapid correction of deformities and more vigorous attempts at restoration of muscle balance.

In combining the roentgen and orthopaedic therapies, the following regimen is carried out: On admission, a complete physical examination is made, measurements of height and measurements of chest and chest expansion are recorded, and photographs and roentgenograms are secured. A thorough search is made for foci of infection, which, if found, are removed. Complete blood studies, which include routine cell and hemoglobin determinations as well as sedimentation rate and Weldman reactions, are carried out. Roentgenotherapy, if not contra-indicated, is given over either the entire spine or the involved area, depending on the clinical findings. Two hundred kilovolts is used in treating areas of about five by fifteen centimeters. One hundred and fifty roentgen units are given over one or more areas daily for three to five treatments; if necessary, the dosage is repeated after three to six weeks.

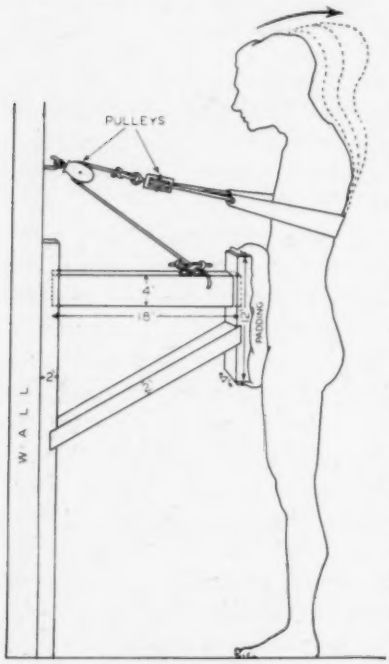

FIG. 2

When needed, blood transfusions are given to build up the patient's general condition and to counteract any effects which the roentgenotherapy may have on the hemopoietic system. If nausea develops during the treatment, intravenous fluids are used, the dosage of the roentgen ray is reduced, and the exposures are spaced farther apart. As soon as the patient has experienced alleviation of pain, attempts at correction of the deformities are started.

The patient is placed on a bed equipped with a sponge rubber or latex mattress with a fracture board. The fracture board is so hinged as to conform to a Gatch bed, and correction is obtained by placing the patient's head toward the foot of the bed as shown in Figure 1. If such a mattress is not available, a Bradford frame is used for this purpose. The patient is given physiotherapy daily,—heat and massage to the abdomen and back, and instructions in corrective exercises. In carrying out exercises in the early cases, it was found that the greatest effect of the forces was gained in the lumbar area, and that little was accomplished in correcting the dorsal curve and in developing the upper sacrospinalis. To overcome this difficulty, the apparatus as demonstrated in Figure 2 was designed. As a means of preventing hyperextension at the lumbosacral junction while using the apparatus, the patient fixes his pelvis with his gluteal and abdominal muscles, and the body strap is put on sufficiently tight to act as a fulcrum and to allow the greatest portion of the hyperextend-

FIG. 3

ing forces to take effect in the region where the strap or belt is fitted.

In warm climates the casts and leather jackets as described by Swaim are uncomfortable; so it was necessary to develop a brace which would maintain and, if possible, give further correction; which would control rotation, and at the same time be comfortable both as to fit and as to body-surface temperature. In trying to meet these requirements the brace illustrated in Figure 3 was designed. It is made of orthopaedic steel five-eighths of

an inch wide and one-eighth of an inch thick. In order to fix the pelvis and thorax as a unit to prevent rotation of the spine, the brace is made sufficiently deep for the side bars to lie in the mid-axillary line (Fig. 3*C*). The appliance is held in place by webbing straps. In addition, a heavy elastic strap is placed at or just below the height of the curve to be corrected (Figs. 3*A* and 3*C*). The elastic strap is fitted sufficiently tight to hold the brace snuggly against the patient's body, and at the same time loose enough not to give too great a pressure across the back. As illustrated in Figure 3*B*, the strap which holds the abdominal pad is made of webbing, but, in some instances this strap is of heavy elastic (although the elastic allows abdominal movement, it discourages low-abdominal expansion with respiration). The abdominal pad can be made larger, and, if to encourage thoracic breathing further fixation of the abdomen is desired, an apron may be attached to the brace in place of the pad; however, the author has found the pad to be more satisfactory, as it does not cause the abdominal distress so frequently seen when too great a pressure is exerted above the umbilicus. The pubic and manubrial pads are hinged freely on the two cross pieces, which are fitted in the pectoral and inguinal regions so as not to interfere with movement of the shoulders and hips (Figs. 3*D* and 3*E*).

Before the introduction of roentgenotherapy, satisfactory correction of deformities in a patient with Marie-Strümpell disease frequently required many weeks of hospitalization, with the patient recumbent on a Bradford frame. The average length of stay with the combined therapy is now ten days. Thus far correction of the deformities has been satisfactory, and there has been little tendency for recurrence. The patients' general well-being has improved, and the sedimentation rate has been lowered in those patients who have had check-up laboratory studies. In a few instances there has been some recurrence of pain, which has subsided satisfactorily with repeated roentgenotherapy, short periods of bed rest, and the application of local heat. Too short a time has elapsed to determine whether the therapy arrests the disease and prevents further ossification of the ligamentous structures of the spine. Early follow-up roentgenograms have shown no increased calcification in the spinal ligaments, and the patients as a whole have maintained the increase which had been obtained in the range of motion. The most satisfactory results have been in the early cases, but surprisingly good improvement has been noted in some of the patients in whom marked deformity and advanced calcification were present.

The author wishes to thank Chester H. Waters, Jr., M.D., for suggesting the use of the elastic straps; and R. J. Reeves, M.D., for supervising the roentgenotherapy.

REFERENCES

Swaim, L. T.: The Orthopaedic Treatment of Strümpell-Marie Arthritis. J. Bone and Joint Surg., XXI, 983, Oct. 1939.

Smyth, C. J.; Freyberg, R. H.; and Lampe, Isadore: Roentgen Therapy for Rheumatoid Arthritis of the Spine (Marie-Strümpell Arthritis; Spondylitis Rhizomélique). J. Am. Med. Assn, CXVII, 826, 1941.

ETIOLOGY OF ASEPTIC NECROSIS OF THE HEAD OF THE FEMUR AFTER TRANSCERVICAL FRACTURE * †

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Sir Astley Cooper, more than 100 years ago, recognized that the disintegration of the head of the femur which frequently followed fracture of the neck was brought on by disruption of the blood supply to the proximal fragment. Axhausen in 1922 described the microscopic changes of aseptic necrosis of the head of the femur.

Santos studied ten femoral heads, obtained at operation or necropsy following intracapsular fractures, and reported that seven were necrotic and three were viable. Of the seven with necrosis, one had been treated by open reduction and insertion of a beef-bone peg, followed by the application of a plaster cast; each of the remaining six had been treated either by the application of a Whitman cast or by traction, or had had no treatment.

Phemister [13] studied the fate of the head of the femur in forty-nine cases. Necrosis occurred in thirty-two, while in seventeen the head survived. There was union of the fracture in four of the cases with necrosis of the head. In seventeen of the forty-nine cases, specimens obtained from fifteen days to four and one-half years after injury were studied microscopically. Partial to complete necrosis was found in fourteen.

Most of the material studied by Phemister and Santos was available only because the result of treatment of the fractures had been unsatisfactory. We hazard the opinion that faulty management of some of the fractures may have contributed to the high incidence of aseptic necrosis in their series.

Incidence of non-union resulting from treatment of intracapsular fractures of the hip by methods of external fixation has been found to be very high. Cleveland and Bosworth reported union in nineteen of forty-eight fractures so treated. Santos found that five out of seven femoral heads, removed from hips in which there were old ununited fractures of the femoral necks, were necrotic. These statistics do not answer the question of cause or effect. Did necrosis result in non-union or were inadequate reduction and poor immobilization factors leading to the death of the head?

The primary etiological factor in aseptic necrosis is disruption of the blood supply to the head of the femur. A complete transcervical fracture may rupture the anterior and posterior capsular vessels, which

* This study was made possible, in part, by a grant from the Douglas Smith Foundation of The University of Chicago.

† Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 6, 1942.

FIG. 1-A

Roentgenogram of proximal end of right femur of Dog 304, removed at necropsy 124 days after fracture, reduction, and accurate pinning. There is bony union, and the head is viable. (See Fig. 1-B.) The left femur of this dog was also fractured, but no reduction or pinning was carried out. The result was complete necrosis and disintegration of the head.

are branches of the circumflex femoral artery. The remaining artery of the ligamentum teres supplies a variable and often relatively small area of the femoral head. Why, then, in some transcervical fractures is there necrosis of the head of the femur, while in others there is complete survival?

The development of techniques for obtaining satisfactory lateral roentgenograms of the hip has undoubtedly resulted in more accurate reduction of transcervical fractures. The teaching of Pauwels has emphasized the importance of relieving the sheering stress by creating a moderate coxa valga position. Secure immobilization of the correctly reduced fragments by means of internal fixation with metal pins, screws, or nails has made union possible in more than 70 per cent. of the cases studied by the Fracture Committee of The American Academy of Orthopaedic Surgeons.[8] Of 157 cases with bony union, twenty-eight or 17.8 per cent. showed degenerative changes in the head of the femur similar to those which Phemister [15] and Freund [9] recognized as the result of aseptic necrosis. The impression might be received from this report of the Fracture Committee that necrosis of the head of the femur has been lessened by the improved

TABLE I

TRANSCERVICAL FRACTURE OF HEAD OF FEMUR, WITH ACCURATE REDUCTION AND PINNING

Dog	Days after Fracture	Function	Union	Condition of Head of Femur
304 (right)	124	Excellent *	Yes	Viable
351 (left)	93	Excellent	Yes	Viable
568	121	Excellent	Yes	Necrosis
579	121	Good †	Yes	Necrosis
774	106	Excellent	Yes	Viable
780	103	Excellent	Yes	Viable

* Excellent function indicates no demonstrable limp, and normal range of motion.
† Good function denotes slight limitation of motion, but active use of the leg.

management of the fractures. However, a study of a control series of comparable cases in which reduction and immobilization were not satisfactory would be necessary in order to answer this question.

An experiment was planned to try to determine whether or not immediate reduction and complete immobilization by internal fixation of the fragments would influence favorably the incidence of aseptic necrosis of the head of the femur. Dogs were selected as the subjects for the study. In thirty-eight instances the hip joint was opened through an anterior incision, and the neck of the femur was divided with an osteotome. In Series 1 (Table I) the fracture was accurately reduced and pinned with two-threaded or three-threaded, stainless-steel wires, gauge .080, with fifty-six threads to the inch (2.5 centimeters). (See Figures 1-A and 1-B.)

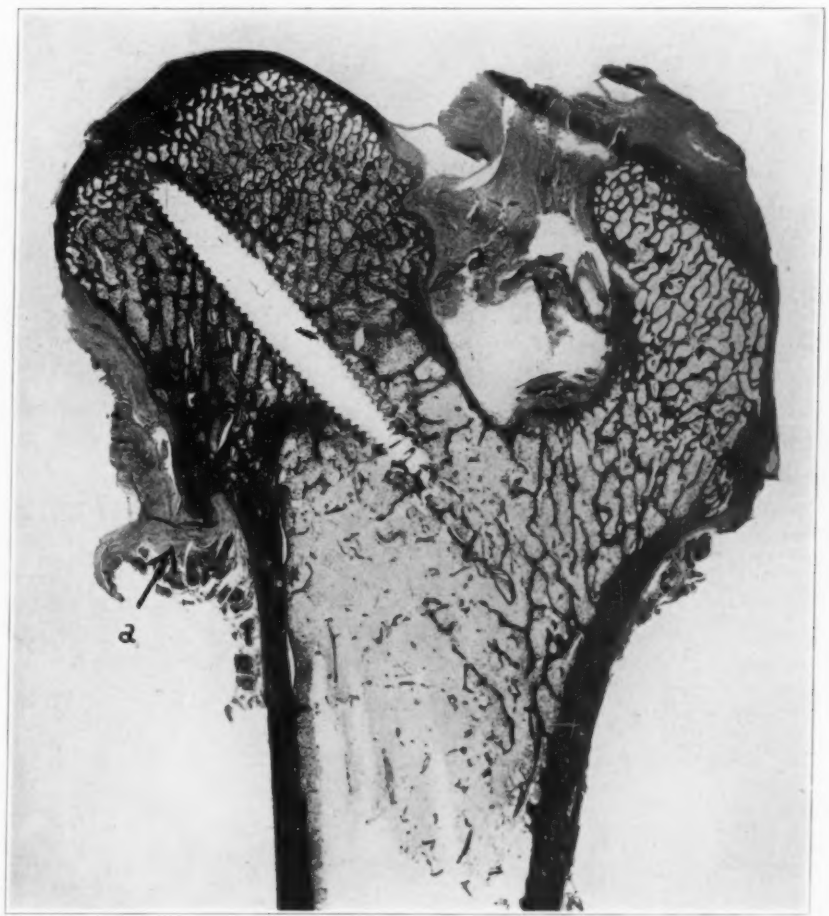

FIG. 1-B

Photomicrographic enlargement of a microscopic section of the right femur of Dog 304. There is normal fatty and hemopoietic marrow throughout. The head is viable. The sharply cut threads made by one of the wires are well demonstrated. The location of the healed fracture is indicated by the arrows.

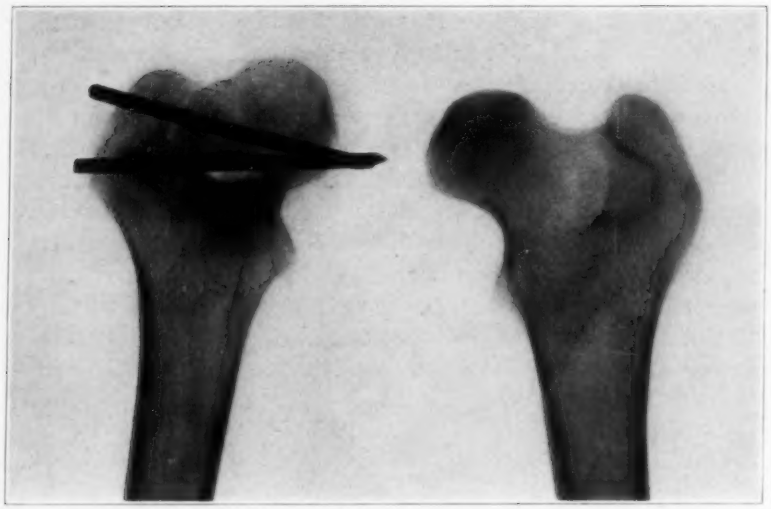

FIG. 2-A

Roentgenogram of proximal portions of femora of Dog 771. The normal femur is included for comparison. The fracture was poorly reduced. The pins pass from the trochanter to the head. The spotty appearance of the head suggested, and microscopic studies (Fig. 2-B) confirmed, the presence of aseptic necrosis with partial replacement.

These wires have been described[7], and their clinical use has been reported[6]. In Series 2 (Table II) the fragments were pinned in a position of inadequate reduction (Figs. 2-A and 2-B), while in Series 3 (Table III) the hip was fractured, and no attempt was made to reduce or to immobilize the fragments (Fig. 3).

No cast or other means of external splinting was used. Within from three to ten days, weight was borne voluntarily on the side of the accurately reduced and pinned fracture, and after from two to three weeks it was difficult to detect any limp. Roentgenograms were made at four-week intervals. Union with or without necrosis developed rapidly. A dog matures and ages at a rate that is about five times as rapid as that of man. Roentgenograms made at intervals of four weeks demonstrated

TABLE II

TRANSCERVICAL FRACTURE OF HEAD OF FEMUR, WITH POOR REDUCTION AND INACCURATE PINNING

Dog	Days after Fracture	Function	Union	Condition of Head of Femur
771	104	Good	No	Necrosis
772	205	Poor *	No	Necrosis
868	119	Excellent	Yes	Viable

* Poor function indicates unwillingness or inability to bear weight on the leg.

that union with or without necrosis of the head was usually definite after eight weeks. Most of these animals were sacrificed within from three to four months after the hip fractures were created.

The loss from infection or distemper was high, and the number of end results studied in the experiments (twenty-one) is not large, but they are consistent and may be regarded as significant. An analysis of the occurrence of union with or without aseptic necrosis is contained in Table IV.

The incidence of necrosis of the head of the femur was high when there was no reduction or when the reduction and internal fixation were not adequate. Yet in two of the six fractures that were reduced and the

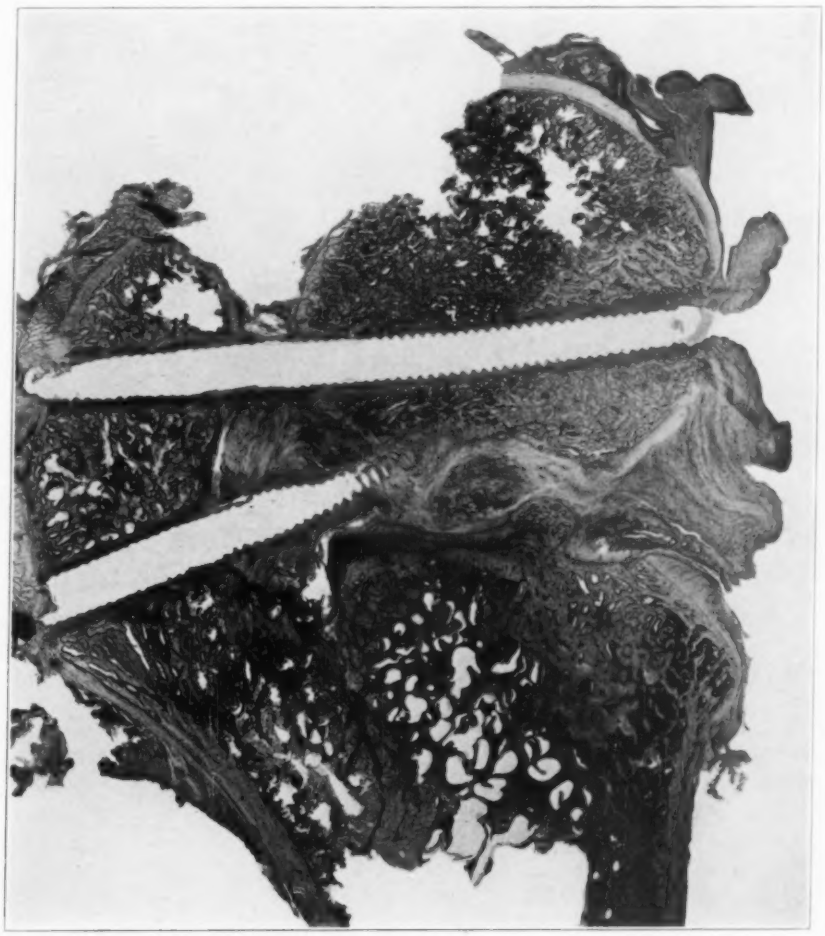

FIG. 2-B

Photomicrograph of a section of the ununited fracture of the femur of Dog 771. (See Fig. 2-A.) The tracks of two threaded wires are shown. The superior two-thirds of the head of the femur is made up of newly formed, living bone with fine trabeculae. The inferior one-third shows thick, poorly stained trabeculae, which are necrotic and have not yet been absorbed or replaced.

fragments pinned, the head was necrotic and partially disintegrated, although there was bony union and function was almost normal (Fig. 4).

FIG. 3

Photomicrograph of a specimen from Dog 908, which consisted of a portion of the ilium (*a*) including the acetabulum and the head of the femur, which was not immobilized. The articular cartilage (*c*) over two-thirds of the head is still of normal thickness. The remnant of head has been replaced (*d*) where blood reaches it through the vessels of the ligamentum teres (*L*). There is a margin of sclerotic dead bone (*e*) adjacent to a dense layer of fibrous tissue (*b*).

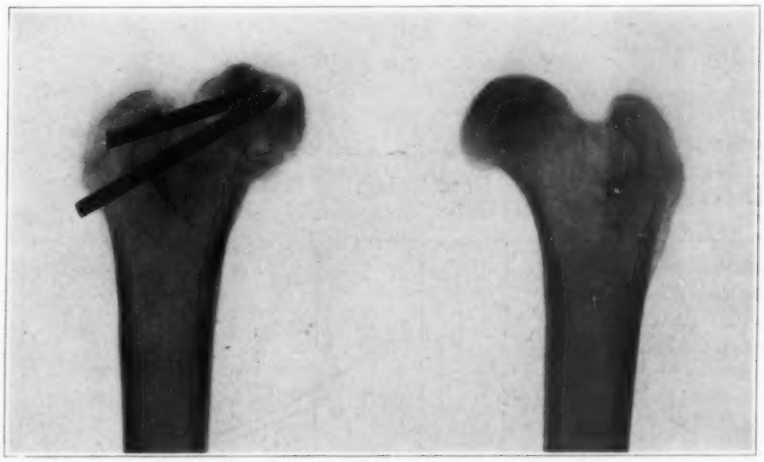

FIG. 4

Roentgenogram of the proximal two-thirds of both femora of Dog 568. After transcervical fracture of one femur, accurate reduction and pinning were carried out. Although union of the fracture followed, the head is necrotic and deformed from weight-bearing. The most advanced absorption and replacement is in the region of the fovea centralis.

DISCUSSION

These experiments indicate that the fate of the head of the femur following transcervical fracture is favorably influenced by immediate accurate reduction and internal fixation. The incidence may be re-

TABLE III

TRANSCERVICAL FRACTURE OF HEAD OF FEMUR, WITHOUT REDUCTION OR PINNING

Dog	Days after Fracture	Function	Union	Condition of Head of Femur
236	104	Poor	Fibrous	Necrosis
304 (left)	124	Poor	None	Necrosis
351 (right)	93	Poor	Fibrous	Necrosis
356	105	Very poor †	Fibrous	Necrosis
777	138	Very poor	None	Necrosis and disintegration
860	114	Poor	None	Necrosis
861	46	Poor	None	Viable
907	91	Good	None	Necrosis and disintegration
908	90	Poor	None	Necrosis
915	106	Fair ‡	None	Irregular atrophy, no collapse
916	132	Poor	None	Necrosis
920 (right) *	83	Poor	None	Viable

* When roentgenograms were made of the pelvis of this dog after operation on the right hip, an old ununited fracture of the left hip, presumably from an accident, was demonstrated. There was necrosis of this femoral head.

† Very poor function denotes no functional use of the leg.

‡ Fair function indicates limited motion, but ability to walk with limp.

TABLE IV

SUMMARY OF TABLES I, II, AND III

Treatment of Fracture	Period between Fracture and Sacrifice	Union		Non-union		Incidence of Survival *Per Cent.*	Total
		Head Viable	Head Necrotic	Head Viable	Head Necrotic		
Accurate reduction and pinning	93–124 days	4	2	0	0	66.66	6
Poor reduction and inaccurate pinning	104–205 days	1	0	0	2	33.33	3
No reduction or pinning	46–138 days	0	3*	3	6	25.00	12
Total		5	5†	3	8	38.09	21

* Fibrous union only.
† Of these 5, only 2 had bony union.

duced, but aseptic necrosis is not eliminated. In some cases the fate of the femoral head is apparently irreparably sealed at the time of the fracture. This is well demonstrated by clinical cases reported by Phemister [13] in which impacted fractures of the transcervical neck of the femur healed, but the head was necrotic and subsequently disintegrated.

Phemister [14] believes that the fate of the head is determined at the time that the fracture occurs and depends almost entirely upon the amount of tearing of the capsular blood vessels or upon the amount of blood distributed to the head through the round ligament. Phemister [16] has expressed the opinion that the relative decrease in the incidence of aseptic necrosis following immediate reduction of the fracture and pinning of the fragments must result from the fact that some of the posterior capsule with its blood vessels remains intact when the neck is fractured. In the unreduced fractures, friction and motion between the fragments may complete the rupture of this posterior capsule and hence result in a higher incidence of necrosis.

Factors which may influence the survival of the femoral head, besides the location of the fracture, include the following: age of the patient, displacement or impaction of the fragments, open or closed reduction, accuracy of the reduction, immediacy of the reduction, elimination of sheering force on fracture line, adequacy of fixation, and choice of materials used in internal fixation.

Multiple minor traumata, produced by the stresses and strains of the daily use of the weight-bearing extremities, have been blamed for aseptic necrosis which occurs as a precursor of flattening or disintegration of the head in malum coxae senilis. Such changes may occur at a much earlier

age if the mechanics of the hip joint are faulty. Aseptic necrosis of the hip has been observed in young adults following closed reduction, during infancy or early childhood, of a congenitally dislocated hip; in association with coxa plana that resulted from Legg-Perthes disease; and in cases of congenitally inadequate acetabulae. Freund [10] has reported the experimental production of osteochondritis dissecans (which is a localized aseptic necrosis) by multiple minor traumata.

The theory of Phemister that the fate of the head following fracture of the transcervical neck is decided *entirely* on a basis of injury to the blood supply to the head at the time of fracture, or by additional tearing of blood vessels in the posterior capsule if weight-bearing is permitted before union takes place, ignores the factors of disturbed mechanics of the hip as well as the theory of minimal traumata. Although it will be difficult to prove, it does seem reasonable to assume that in some cases following fracture the femoral head *may survive*, but with little more than enough blood supply to maintain viability without the stresses and strains of weight-bearing activity. If minimal traumata can produce changes of aseptic necrosis in the head of a femur in which there has been *no* fracture or dislocation, it would not be illogical to *anticipate* late necrosis in the head of a femur which has survived the fracture and united following reduction. This would be more likely to occur if the mechanics of the hip joint were faulty because of poor reduction and malunion of the fragments.

That old age is not a primary etiological factor is shown by the report of Wilson and that of Carrell and Carrell; these authors observed the frequent occurrence of aseptic necrosis in the head of the femur in children following transcervical fracture. A review of the study of twelve hips reported by Carrell and Carrell leads to the interesting observation that of five hips in which the initial reduction was unsatisfactory, aseptic necrosis developed in three, and a fourth hip became ankylosed. Of seven hips in which the fracture was initially accurately reduced and adequately immobilized, aseptic necrosis developed in only one. The fact that the results described as "fair" and "poor" were reported from four to fifteen years after fracture, while the postfracture period of those classed as "good" was only from one to two years, may be as significant as the question of management of the fresh fracture.

King, in reporting a very comprehensive study of final results in recent and old intracapsular fractures of the femoral neck, has stated that those which have not been reduced and immobilized within three weeks after fracture should be arbitrarily called old and ununited. He adds that, lacking contact with the vascular distal fragment, the head of the femur will not survive as often as when early reduction and fixation of fragments are carried out. The experiments which we have reported support this hypothesis.

Banks has reported necrosis of the head of the femur following traumatic dislocation without fracture. Such dislocations are accom-

panied by complete rupture of the ligamentum teres, but the extent of injury to the capsular vessels has not been determined. Necrosis following simple traumatic dislocations suggests that the blood supply via the ligamentum teres is more important than has been generally recognized.

Those who have studied the end results of fracture of the transcervical neck of the femur in any considerable number of cases will have observed at some time necrosis with collapse of the head, which has become manifest years after healing of the fracture. Union of a fracture of the neck of the femur, regardless of the method of reduction or of immobilization, does not of itself constitute an end result. The condition of each head of the femur should be studied at intervals for at least five years after union and beginning weight-bearing by those surgeons who are qualified by training and experience to recognize roentgenographic changes and to interpret them in terms of pathological processes such as aseptic necrosis.

SUMMARY AND CONCLUSIONS

Necrosis of the head of the femur occurs less often if the fracture of the transcervical neck is immediately and accurately reduced and adequately immobilized.

In the experiments carried out by the authors, necrosis with collapse of the weight-bearing portion of the cortex of the head occurred in two of six cases following accurate reduction of the fracture and pinning of the fragments, although the fracture united. In these two cases the head of the femur may have been viable when union occurred, but, with partially depleted blood supply, the minimal traumata of continued use and weight-bearing may have resulted in the necrosis and disintegration.

The prognosis for survival of the head of the femur is definitely less satisfactory if the reduction of the fracture is not anatomically correct or if pinning of the fragments is not adequate for complete immobilization.

Death of the head of the femur when the fracture was neither reduced nor immobilized was found to occur in nine of twelve hips studied. It is possible that weight-bearing activity and friction between the fragments may have ruptured blood vessels that were left intact after fracture in a portion of the posterior capsule. However, this theory does not explain the difference in incidence of necrosis in cases in which the head was pinned without accurate reduction and in those in which the head was pinned in an anatomically correct position.

REFERENCES

1. Axhausen, G.: Die Nekrose des proximalen Bruchstücks beim Schenkelhalsbruch und ihre Bedeutung für das Hüftgelenk. Arch. f. Klin. Chir., CXX, 325, 1922.
2. Banks, S. W.: Aseptic Necrosis of the Femoral Head following Traumatic Dislocation of the Hip. A Report of Nine Cases. J. Bone and Joint Surg., XXIII, 753, Oct. 1941.
3. Carrell, Brandon, and Carrell, W. B.: Fractures in the Neck of the Femur in Children with Particular Reference to Aseptic Necrosis. J. Bone and Joint Surg., XXIII, 225, Apr. 1941.

4. Cleveland, Mather, and Bosworth, D. M.: Fractures of the Neck of the Femur. A Critical Analysis of Fifty Consecutive Cases. Surg. Gynec. Obstet., LXVI, 646, 1938.
5. Compere, E. L.: The Ambulatory Treatment of Recent Fractures of the Intracapsular Neck of the Femur following Threaded Wire Fixation. J. Internat. Coll. Surgeons, III, 401, 1940.
6. Compere, E. L., and Lee, John: The Restoration of Physiological and Anatomical Function in Old Ununited Intracapsular Fractures of the Neck of the Femur. J. Bone and Joint Surg., XXII, 261, Apr. 1940.
7. Compere, E. L.; Wallace, George; and Lee, John: Materials for Internal Fixation of Intracapsular Fracture of the Neck of the Femur. Arch. Surg., XLIV, 327, Feb. 1942.
8. Fracture Committee of The American Academy of Orthopaedic Surgeons: Treatment of Fractures of the Neck of the Femur by Internal Fixation. J. Bone and Joint Surg., XXI, 483, Apr. 1939; XXIII, 386, Apr. 1941.
9. Freund, Ernst: Zur Frage der aseptischen Knochennekrose. Virchows Arch. f. Path. Anat., CCLXI, 287, 1926.
10. Freund, Ernst: Osteochondritis Dissecans of the Head of the Femur. Partial Idiopathic Aseptic Necrosis of the Femoral Head. Arch. Surg., XXXIX, 323, 1939.
11. King, Thomas: The Closed Operation for Intracapsular Fracture of the Neck of the Femur. Final Results in Recent and Old Cases. British J. Surg., XXVI, 721, Oct. 1939.
12. Pauwels, Friedrich: Der Schenkelhalsbruch: ein mechanisches Problem. Grundlagen des Heilungsvorganges Prognose und kausale Therapie. S. 6. (Beilageheft z. Ztschr. f. Orthop. Chir., LXIII.) Stuttgart, Ferdinand Enke, 1935.
13. Phemister, D. B.: Fractures of Neck of Femur, Dislocations of Hip, and Obscure Vascular Disturbances Producing Aseptic Necrosis of Head of Femur. Surg. Gynec. Obstet., LIX, 415, 1934.
14. Phemister, D. B.: Changes in Bones and Joints Resulting from Interruption of Circulation. I. General Considerations and Changes Resulting from Injuries. Arch. Surg., XLI, 436, 1940.
15. Phemister, D. B.: Changes in Bones and Joints Resulting from Interruption of Circulation. II. Nontraumatic Lesions in Adults with Bone Infarction; Arthritis Deformans. Arch. Surg., XLI, 1455, 1940.
16. Phemister, D. B.: Personal Communication.
17. Santos, J. V.: Changes in the Head of the Femur after Complete Intracapsular Fracture of the Neck. Their Bearing on Nonunion and Treatment. Arch. Surg., XXI, 470, 1930.
18. Wilson, J. C.: Fractures of the Neck of the Femur in Childhood. J. Bone and Joint Surg., XXII, 531, July 1940.

MEASUREMENTS OF THE STRENGTH OF TRUNK MUSCLES *†

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From the Hospital for Joint Diseases, New York

When in 1932 Lowman presented his paper on the reinforcement of weak abdominal muscles by fascial grafts, he stimulated an interest in one of the major factors causing paralytic deformities. Particular credit is due him, since, until then, scant attention had been paid to the study of paralyzed abdominal muscles, although one of us (L.M.) had indicated their importance in a paper on "Fixed Paralytic Obliquity of the Pelvis", published in January 1931. Lowman described certain tests which he made to determine the strength of these muscles, and additional modes of estimating their power were recorded by the senior author in a second

FIG. 1

Photograph of swivel table, showing the scale clamped to the side bar.

* Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 5, 1942.

† This research was aided by a grant from The National Foundation for Infantile Paralysis, Inc.

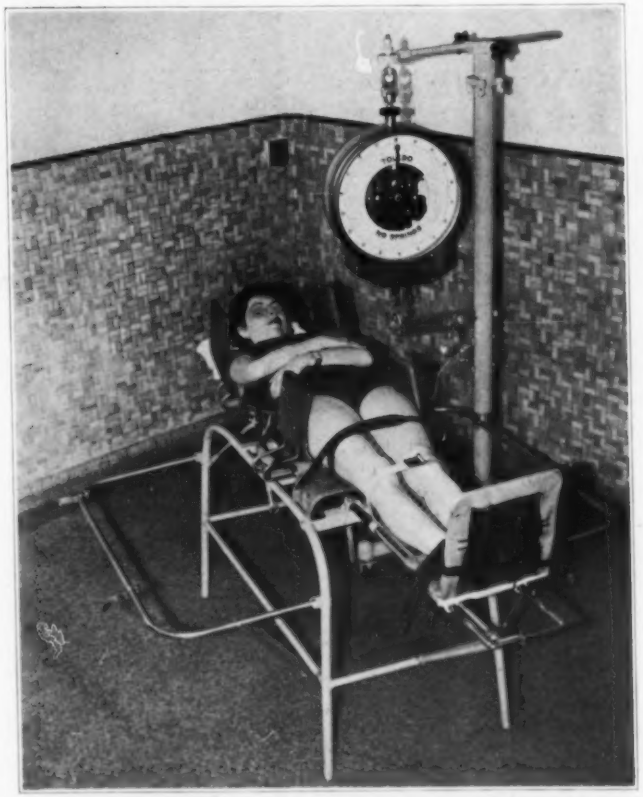

FIG. 2

Patient is strapped to the table. The body is in the neutral position preparatory to the tests for the right lateral trunk muscles.

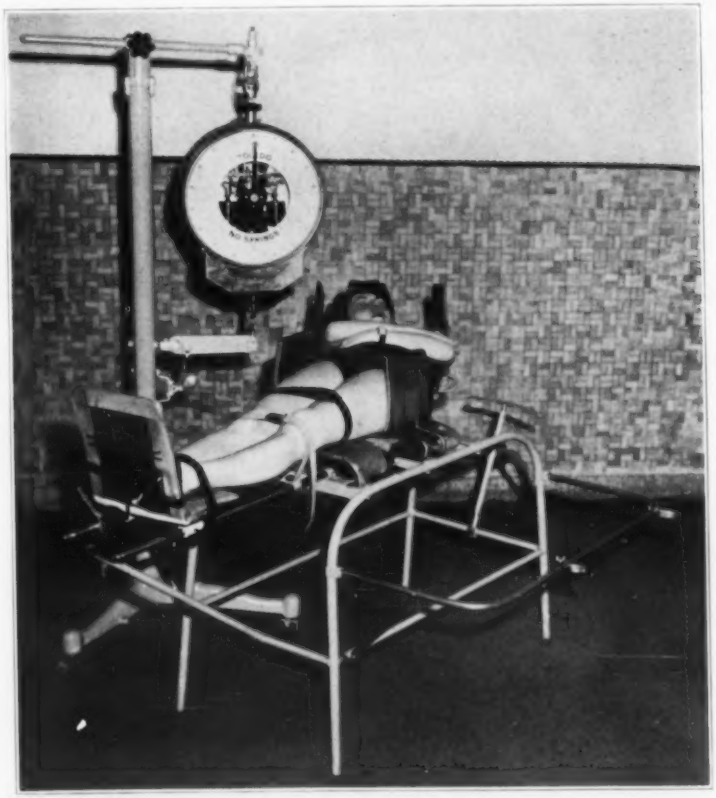

FIG. 3

Patient is strapped to the table preparatory to testing the left lateral trunk muscles. The body has been bent toward the right, so as to put the left lateral trunk muscles on the stretch.

paper entitled "Further Studies of Fixed Paralytic Pelvic Obliquity", published in January 1936. These methods, although of some value, were from their very nature essentially subjective,—that is, dependent upon the judgment of the particular surgeon who made them. The criterion which was applicable to muscles of the extremities—namely, the power to contract against the weight of the limb—could not be used for the trunk muscles. Consequently, trunk muscles were graded as "good", or "fair", or "poor" in a rather haphazard fashion.

To overcome this obvious weakness in our methods of examining patients suffering from the residual paralysis of poliomyelitis, we have devised a method, which, so far as we can tell at present, gives us valuable information. The essential is a swivel table (Fig. 1), a refining of a crude model made by one of us, shown in Figure 8 of the second article on pelvic obliquity. The original wood has been replaced by metal, the clumsy pivot by ball bearings, the inaccurate recording system of a spring balance attached to ropes running over pulleys by a precise gravity scale, but the essential principle of our present method is the same as that of the original procedure. The new table consists of two parts,—a stationary foot-piece and a movable body-piece so mounted that it can swing from side to side on ball bearings with minimal friction. The legs can be firmly strapped

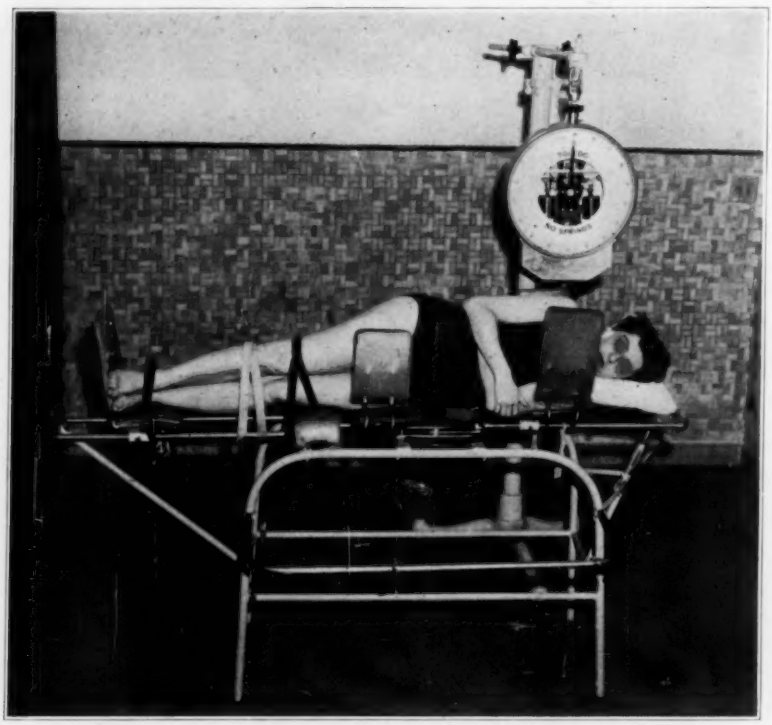

FIG. 4

Patient is in the neutral position for testing the flexor muscles of the trunk.

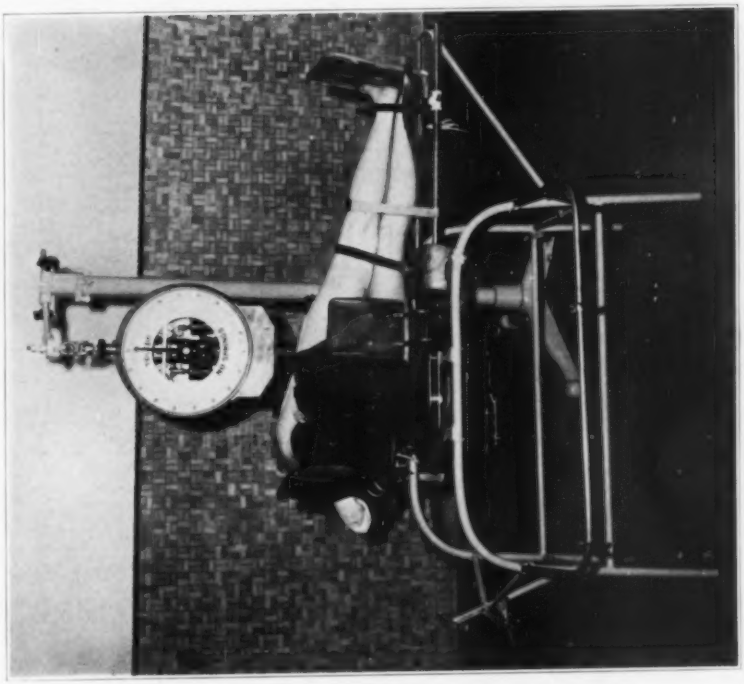

FIG. 6

Patient is in position preparatory to testing the extensor muscles of the trunk. The body has been flexed to put the extensor muscles on the stretch.

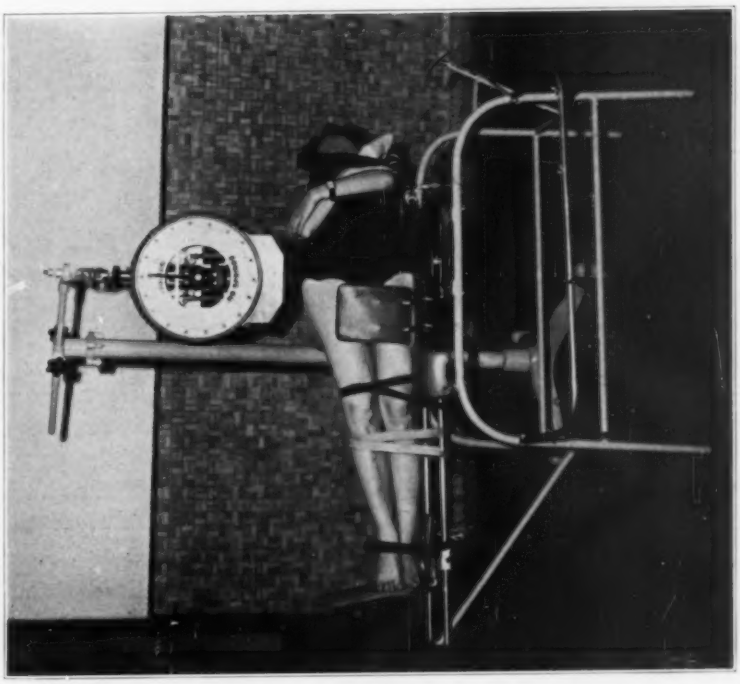

FIG. 5

Patient is in the hyperextended position preparatory to testing the flexor muscles. These have been put on the stretch by the hyperextended position.

GRAPH OF COMPARATIVE STRENGTH OF RIGHT LATERAL TRUNK MUSCLES, CONTRACTING FROM NEUTRAL AND FROM STRETCHED POSITIONS

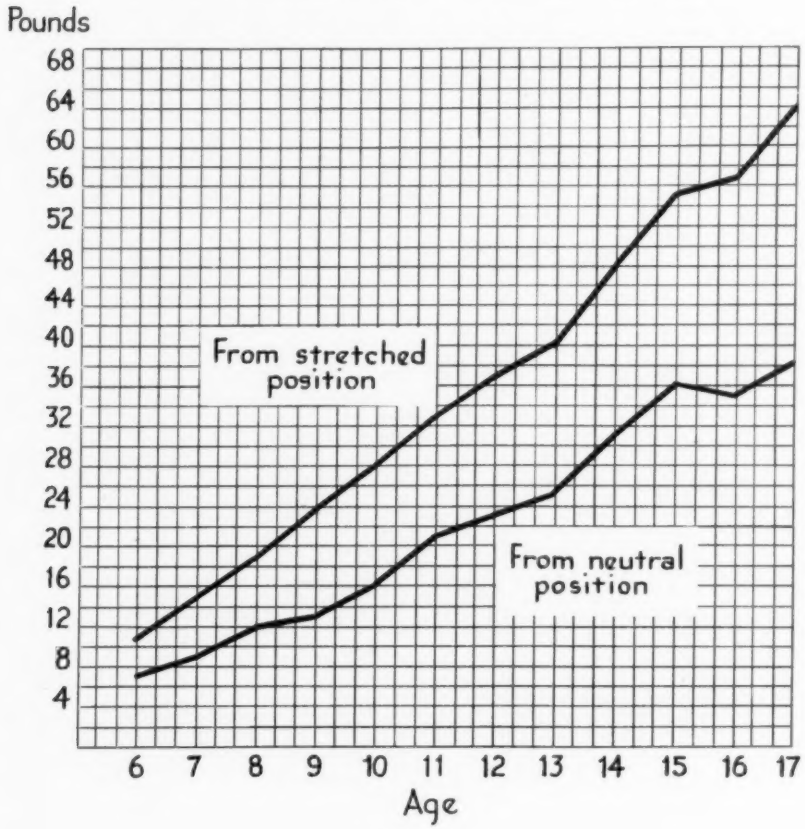

FIG. 7

This graph illustrates the increased power of the lateral trunk muscles when put on the stretch.

to the foot-piece; the pelvis is supported by adjustable leather pads; and the body is held securely in place by straps and chest pads. A steel cord runs from the side of the body section of the table to the scale, which is locked in position by a clamp attached to an adjustable horizontal bar. This type of recording device is far more accurate than the spring-balance method of Lovett, which we used for more than a year before convincing ourselves of its inaccuracy. The spring balance permits too much subjective variation in the hands of different examiners, and too great a range of body motion with a consequent shift of the angle of force application and a variation in the strength of the contracting muscles. Because of these variations, numerous discrepancies were noted, which forced us to discard our measurements made by this method in 300 cases. The gravity scale, when fixed to the horizontal bar, eliminates these variations and gives consistent readings with different observers.

GRAPH OF STRENGTH OF RIGHT LATERAL TRUNK MUSCLES OF 550 NORMAL BOYS AND GIRLS. TRUNK SWINGS TO RIGHT FROM NEUTRAL POSITION

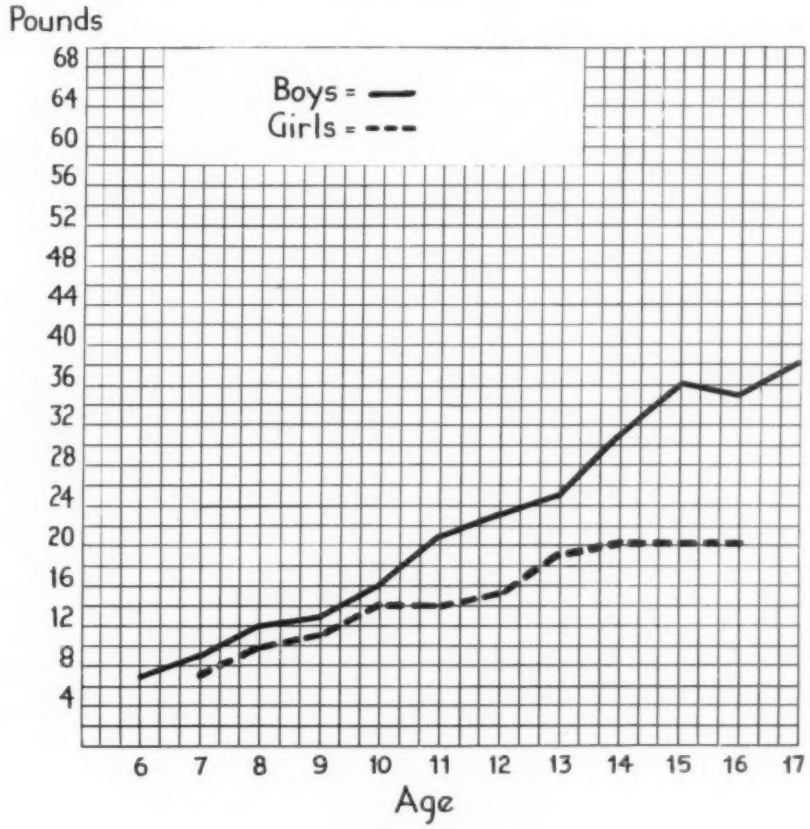

FIG. 8

This graph illustrates the difference in the muscle strength of boys and girls. The girls do not increase in strength after the fourteenth year, whereas the boys continue to gain.

It is of course obvious that this method of measuring muscle strength applies to groups of muscles, and not to an individual muscle. It is possible to measure the strength of the lateral flexors of the trunk of the right and left sides, the extensors, and the trunk flexors, but not of the rectus abdominis or of the obliquus externus abdominis. Even the muscle groups, however, do not act with complete independence; thus, when the extensors of the trunk contract against a strong resistance, the legs are braced by the thigh and calf muscles, and even the arm muscles try to aid the trunk. To this degree, our method is inaccurate, but in this very fact lies an important practical application of the test, for the normal action of the trunk muscles is invariably coordinated with action of the muscles of the extremities. Thus, in lifting a weight—predominantly an action of the trunk extensors—the legs must be braced and the arms held

GRAPH OF STRENGTH OF RIGHT LATERAL TRUNK MUSCLES OF 550 NORMAL BOYS AND GIRLS. TRUNK SWINGS TO RIGHT FROM LEFT LATERAL FLEXION

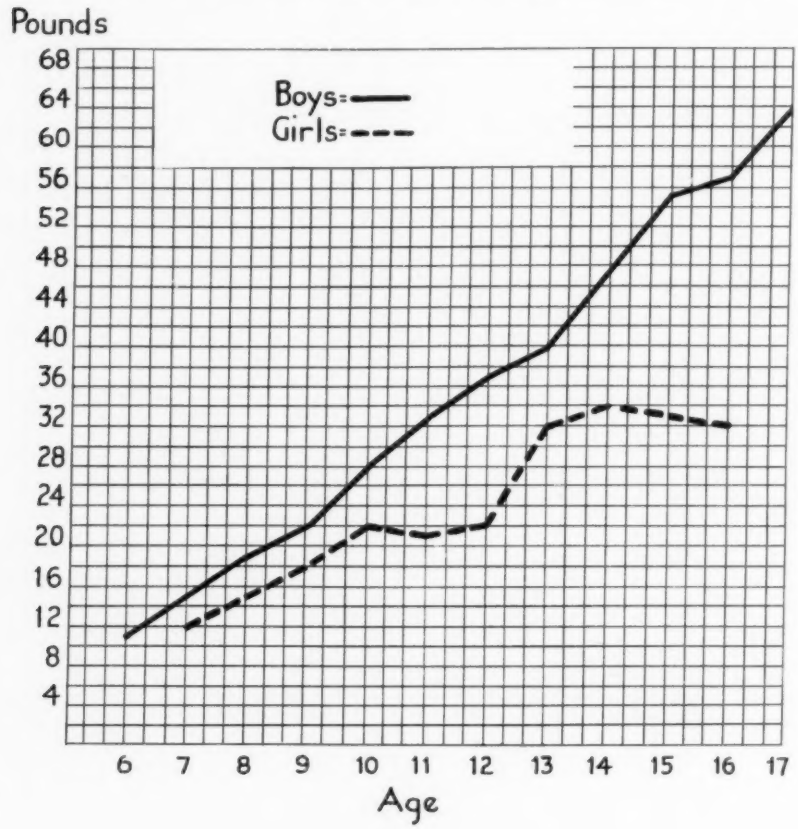

FIG. 9

This graph also illustrates the marked difference in muscle strength between the boys and the girls.

taut. Our test, therefore, serves to give an accurate idea of the strength of the body in performing certain actions.

Although our primary object was the measurement of pathological muscles, the normal had to be studied first in order to set up a table of norms. To do this, measurements were carried out on 550 children, ranging in age from seven to seventeen years. The following tests were made: The child was strapped to the table in the supine position (Fig. 2) and was then asked to swing the body to the right. This body effort was transmitted through the steel cord to the scale and gave a reading in pounds. The test was repeated a few times until the child understood just what was expected of him, and then two final readings were taken. The actual excursion of the table during the test is extremely slight,—not more than 5 degrees; therefore, the line of force does not vary much from the perpendicular. We soon found that the strength of the muscles

GRAPH OF STRENGTH OF FLEXOR MUSCLES OF 550 NORMAL BOYS AND GIRLS. TRUNK SWINGS FORWARD FROM NEUTRAL POSITION AND FROM HYPEREXTENDED POSITION

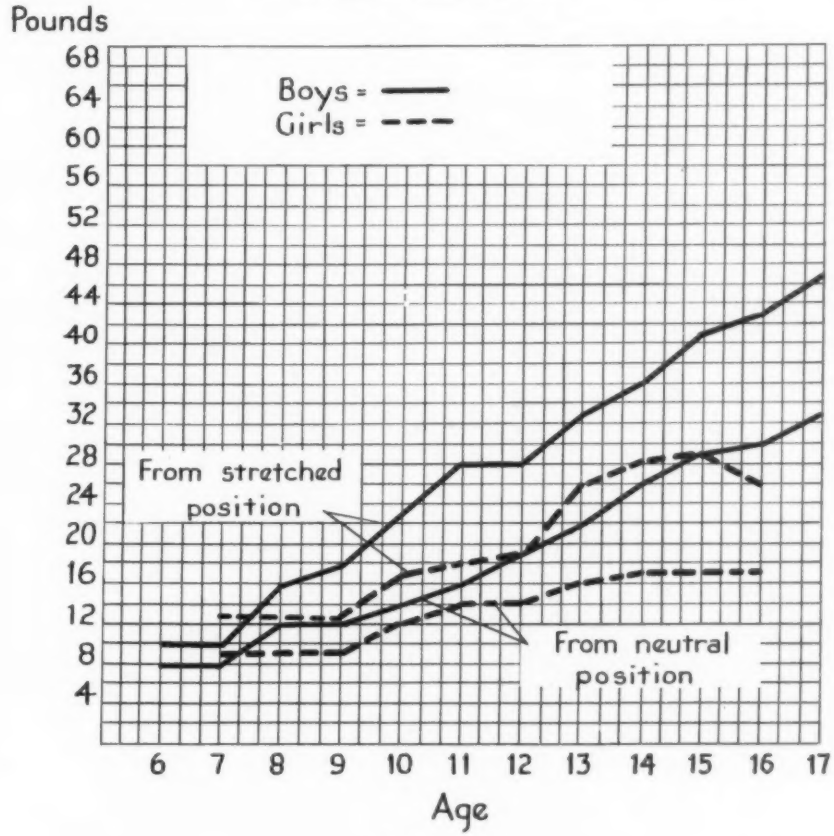

FIG. 10

This graph shows that the power of the flexor muscles is definitely less than that of the lateral trunk muscles.

varied considerably with the position of the trunk at the start of the test. Thus, if the body was first bent strongly to the left, so as to put the right lateral trunk muscles on the stretch, these muscles showed much more power than when the starting position was the neutral mid-line. It thus became evident that the groups of muscles would have to be tested from two positions,—a neutral or so-called resting position and a stretched position in which the muscle fibers were passively elongated to their normal limit. Let us here point out that we are not attempting to record the so-called moment of the muscles,—that is, the product of their contractile power multiplied by the range of the contraction. We are only recording the muscle strength during one small phase of its contraction,—namely, through an arc of about 5 degrees.

After the right lateral trunk muscles were tested from the neutral

and the stretched positions, the left lateral trunk muscles were recorded (Fig. 3). For gauging the flexors and extensors, the children were placed on their sides, first on the right and then on the left (Fig. 4). For both groups, tests were made from the neutral position and from the stretched position (Figs. 5 and 6).

The records of the 550 children examined were grouped according to

GRAPH OF STRENGTH OF EXTENSOR MUSCLES OF 550 NORMAL BOYS AND GIRLS. TRUNK SWINGS BACKWARD FROM NEUTRAL AND FROM EXTREME FLEXION

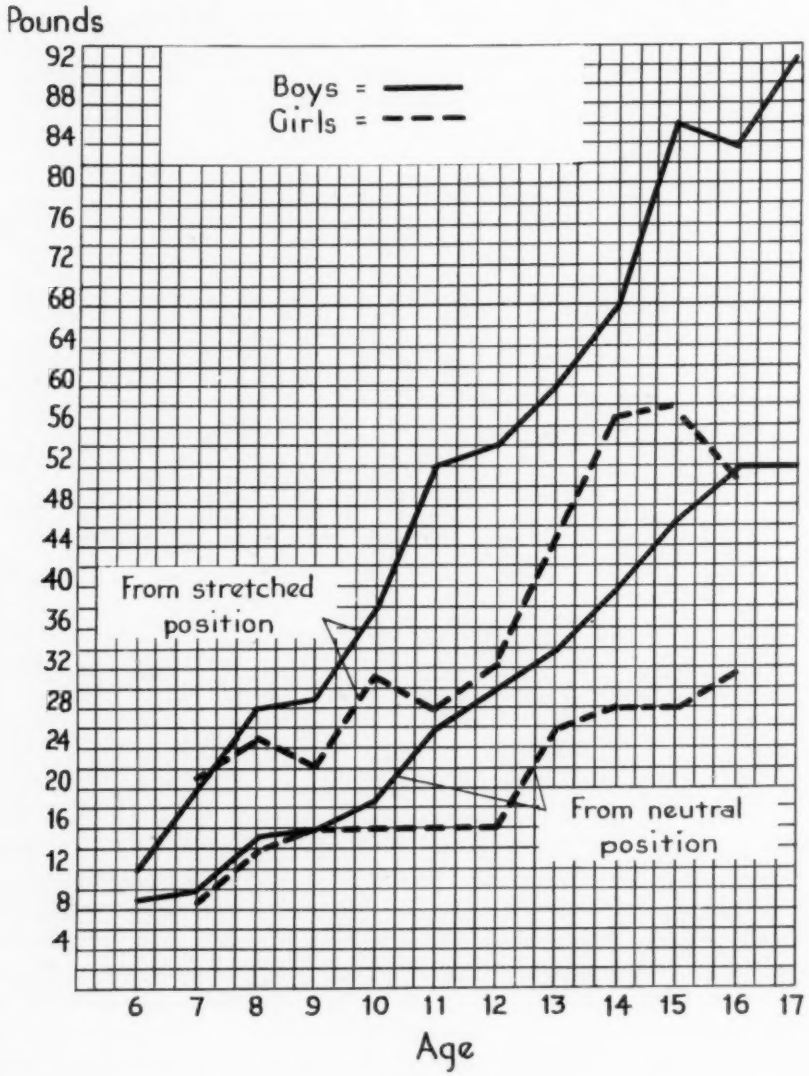

FIG. 11

Showing that the extensor muscles are stronger than the lateral trunk muscles.

age and sex. Tabulations were then made, so as to get the average of each muscle group for each age and sex. By this method graphs were constructed which gave us a table of norms by means of which pathological variations in muscle strength could be estimated (Fig. 7).

These graphs have given us information which may be of some significance, not only for the interpretation of paralytic conditions, but in

GRAPH OF COMPARATIVE STRENGTH OF LATERAL TRUNK MUSCLES, FLEXORS, AND EXTENSORS OF 250 NORMAL BOYS CONTRACTING FROM THE STRETCHED POSITION

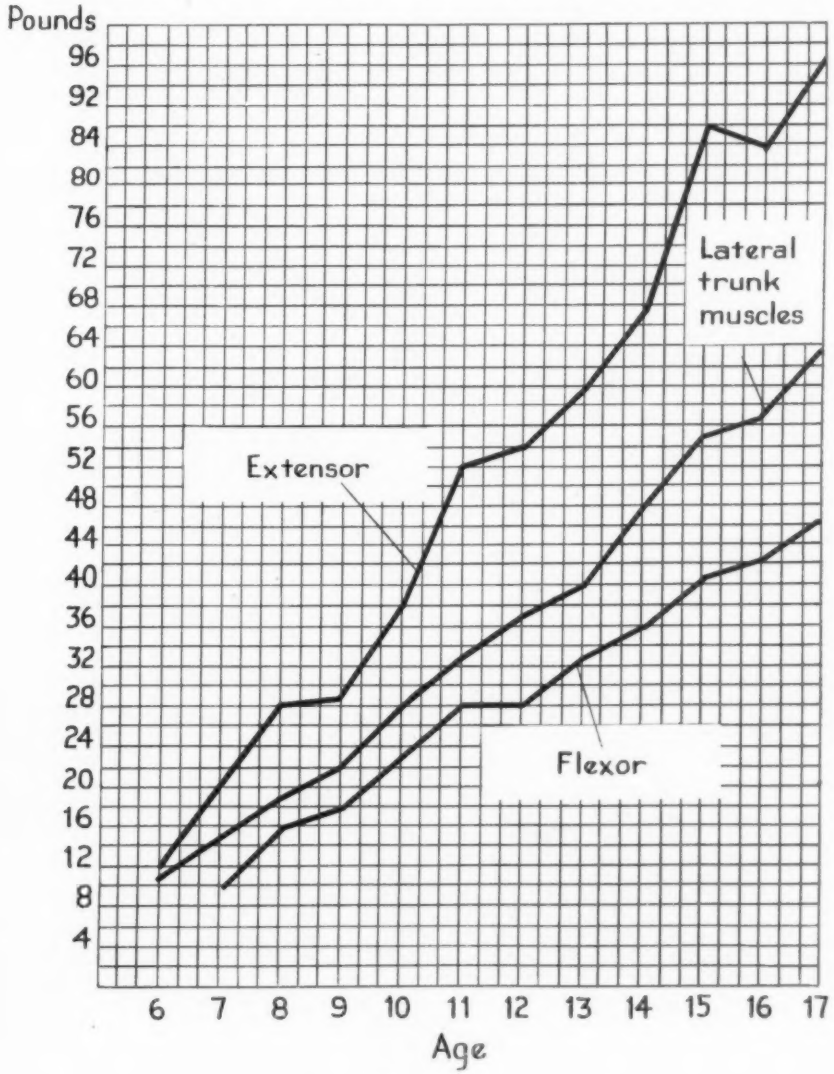

FIG. 12

This graph shows that the strength of the lateral trunk muscles is between that of the flexors and the extensors. The ratio of the three groups is approximately 3:4:6.

the study of posture and the evolution of scoliosis. In all, there was a striking difference between the boys and girls. The two sexes parallel one another rather closely until the fourteenth year; then there occurs a marked disparity. The graph of the girls forms a horizontal line, whereas the graph of the boys ascends steeply (Figs. 8 and 9). In other words, the seventeen-year-old girl has no more strength in the trunk muscles than has the fourteen-year-old, but the boys developed more rapidly during these three years than during any other comparable period. Thus it happens that the seventeen-year-old boy has almost always twice as much strength as the girl of the same age.

A fairly constant ratio has been found between the strength of the trunk flexors and that of the trunk extensors. The extensors are invariably more powerful, and the ratio is almost two to one. Midway

GRAPH OF COMPARATIVE STRENGTH OF RIGHT AND LEFT LATERAL MUSCLES OF 250 NORMAL BOYS. TRUNK SWINGS FROM NEUTRAL POSITION

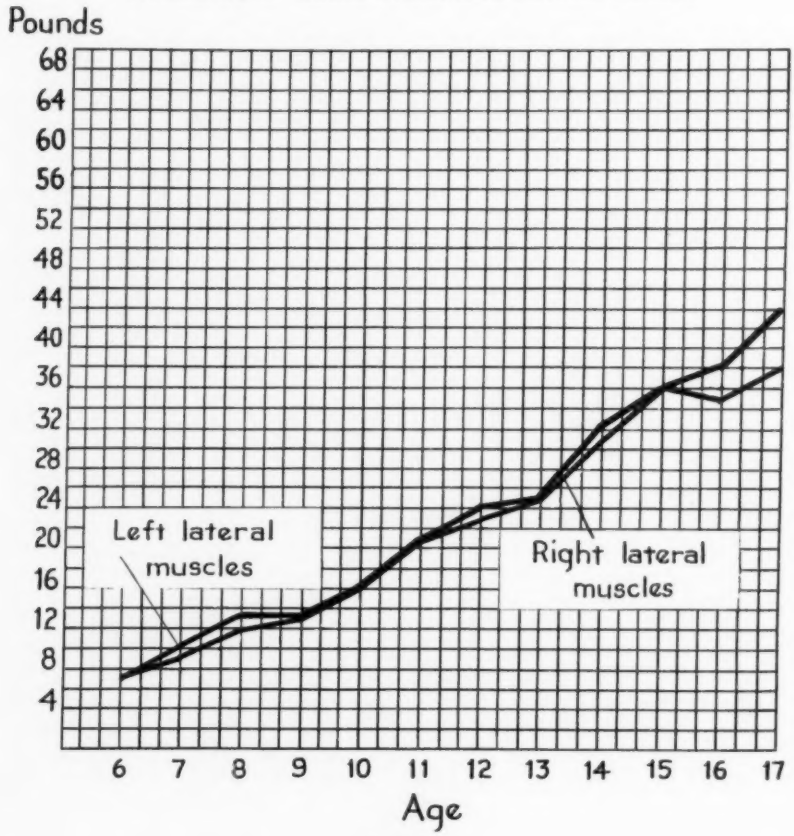

FIG. 13

This shows that there is slightly more strength in the left lateral muscles than in the right lateral muscles. This may be due in part to the slight extra strength of the right leg and arm, which are used in supplementing the left lateral trunk muscles.

between these two are the lateral trunk muscles. (See Figures 10, 11, and 12.) This relationship makes it easy to detect pathological variations due to paralysis of one group.

We had expected an accurate correspondence of the muscles of the right side with those of the left side, but, to our surprise, we found that the left lateral group throughout the series had a slight predominance over the right (Fig. 13). It must be remembered, however, that these tests are not records of the trunk muscles alone, for the leg and arm muscles are also used, although to a lesser degree. As the left trunk muscles contract, the right thigh and right arm brace against the fixation pads. It may well be, since most of the children examined were right-handed, that the discrepancy in power between the right and left trunk muscles was due, in part at least, to the predominance of the right extremities over the left. Irrespective of this explanation, the fact remains that in 550 normal children the muscle strength in the two sides does not exactly correspond. To us this was a new fact which we wish to check by additional observation and careful controls. If it is true, it may serve as an important factor in the development of the so-called idiopathic scoliosis.

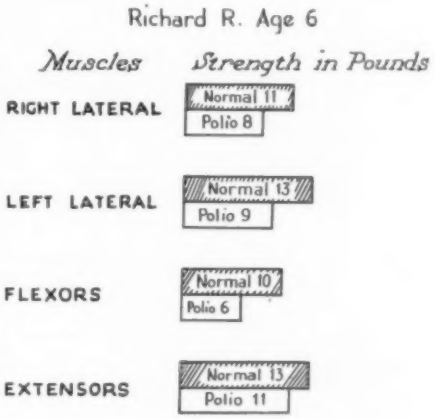

FIG. 14

This chart of a poliomyelitis patient shows the comparison in the strength of paralyzed and normal muscles. In this case pelvic obliquity or scoliosis failed to develop, largely because the right and left lateral muscles are almost of the same strength, and the three groups of muscles have preserved their normal ratio.

About fifty cases of poliomyelitis were studied. Almost all were in the chronic stage. The strength of the trunk muscles had been graded from zero to five, according to clinical methods already published. When these grades were compared with the tests on the swivel table, many discrepancies were found. Our results can best be summarized by citing a few typical instances:

Richard R., aged six (Fig. 14). In this patient both legs were extensively paralyzed, and the trunk muscles had been graded as follows: right lateral, 2−; left lateral, 4; flexors, 3−; extensors, 4−. Despite the difference in the strength of the right and left lateral muscles, no pelvic obliquity or scoliosis had developed during a period of five years since the onset of the paralysis.

These observations did not accord with what we had seen in other similar cases, since usually, with this difference in the strength of the lateral muscles of the two sides, pelvic obliquity and scoliosis had been the rule. The swivel-table test showed that our clinical examination was incorrect. The difference between the right and left sides was extremely slight,—namely, one pound. The extensors which had been rated 4−

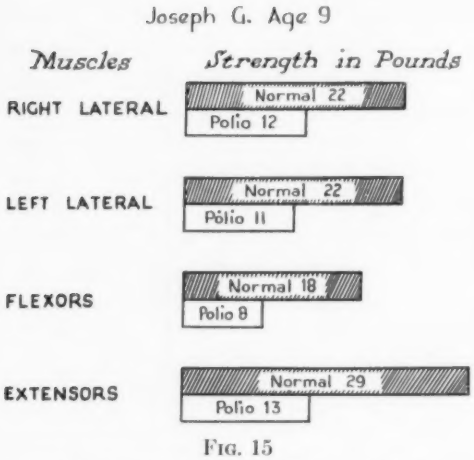

FIG. 15

In this chart of a poliomyelitis patient, a boy, aged nine, the muscle strength corresponds accurately to that of a child of six.

were in reality almost normal. The swivel table helped us to explain why Richard had not developed pelvic obliquity and scoliosis.

Joseph G., aged nine (Fig. 15). This boy had an involvement of the right foot, with good hip muscles and apparently good trunk muscles, which we had rated as 5. The swivel table proved that we had overestimated their strength. The flexors proved to have 44 per cent. of the normal strength; the extensors, 45 per cent.; the left lateral 50 per cent., and the right lateral 55 per cent. When the strength of his muscles was compared with that of a six-year-old child, it was found that they were almost the same. There was a variation in the normal relationship between the strength of the lateral muscles and the flexors and the extensors.

Since this child of nine had approximately the same strength as a six-year-old, obvious conclusions were necessary with regard to the treatment and the physical response which we might expect.

Harriet R., aged thirteen (Fig. 16). In this patient the clinical test showed a forward tilting of the pelvis and a marked lordosis, due to a weakness of the abdominal muscles. These muscles had been rated as follows: lateral, 3; anterior, 2. The patient

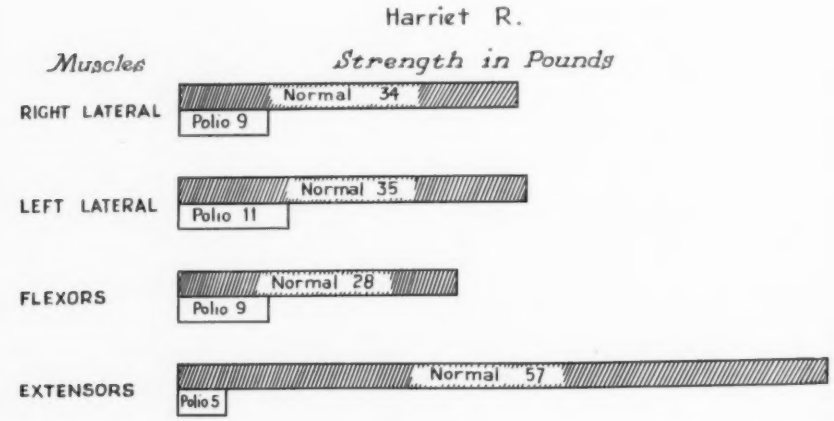

FIG. 16

This chart of a poliomyelitis patient shows that, although the clinical tests emphasized the weakness of the abdominal muscles, resulting in a sagging of the abdomen and increased lordosis, the most marked weakness was of the extensor muscles of the trunk.

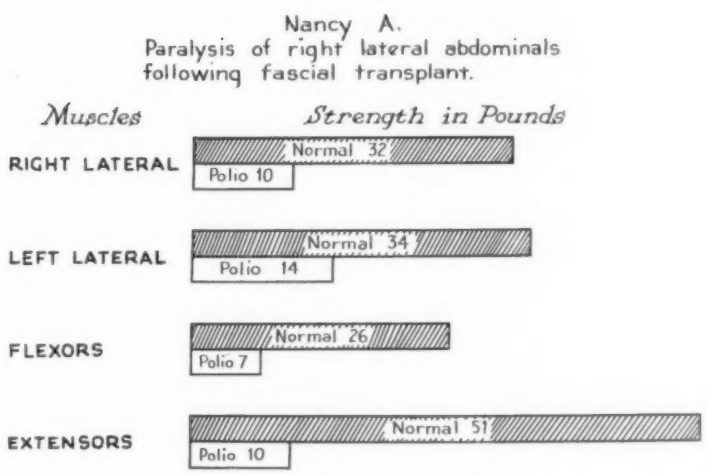

FIG. 17

In this case there had been a complete paralysis of the right lateral trunk muscles, resulting in a fixed paralytic pelvic obliquity. The right side was four inches lower than the left. Following a fascial transplantation, running from the right ilium to the ninth rib on the right side, the pelvic obliquity was markedly reduced, and the patient, who previously had been unable to stand alone, was able to walk a half mile and climb a flight of steps. The improvement is indicated in the chart, which shows considerable strength in the right lateral trunk muscles.

also had a progressive scoliosis and her extensor muscles were rated as 3. The swivel table, however, gave us another impression. This test showed that the extensors were much weaker than the other trunk muscles. They had a pull of only five pounds as compared with the normal fifty-seven pounds, or less than one-tenth of normal strength; whereas the flexors, though weak, had one-third of normal strength, and the laterals had little more than one-quarter. Recently two operations have been performed on this patient,—a spine fusion and bilateral fascial transplantations.

It will be illuminating to observe the effect of these operations.

In two cases we have had a chance to make tests following fascial transplantations to reinforce weak or absent abdominal muscles.

Nancy A., aged sixteen (Fig. 17). This patient had a pelvic obliquity of four inches, due to an

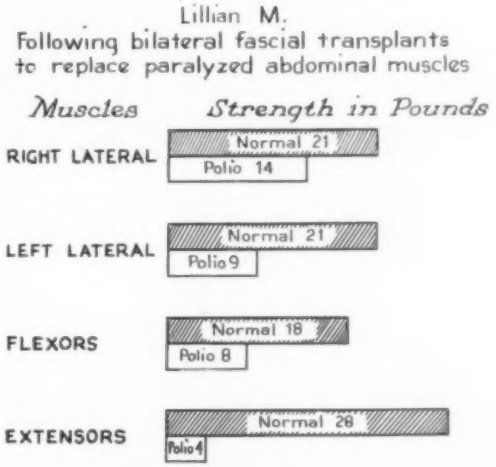

FIG. 18

In this case bilateral fascial transplantations were done to support the weakened abdominal muscles. The fascial strips ran from the ilium to the ninth rib on both sides. The chart shows that the abdominal muscles have improved markedly, although the extensors are still far below the normal strength.

almost complete absence of the right lateral abdominals and the right quadratus lumborum. After the fascial transplantation, the pelvic obliquity was reduced to one inch, and the patient, who previously could not walk alone, was able to walk a half mile and climb a flight of steps. The swivel table showed that the right lateral abdominals had approximately one-third of normal strength, and the left only a little more (two-fifths of the normal). In other words, the fascial transplantation had done much to re-establish muscle balance.

Lillian M., aged twelve (Fig. 18). This patient had bilateral abdominal paralysis, resulting in marked sagging of the abdominal wall, forward tilting of the pelvis, and extreme lordosis. Bilateral fascial transplantations were done, resulting in marked improvement. This was evident by the swivel-table tests, which showed the paralyzed flexors to have almost one-half the normal strength.

We conclude from our observations that in the swivel table we have a means of evaluating power of trunk muscles more accurately than by the previous clinical tests. There is a chance that through these tests we may be able in the future to learn more about the cause of postural defects, painful backs, and scoliosis, as well as about the residual paralyses of poliomyelitis.

REFERENCES

LOWMAN, C. L.: The Relation of the Abdominal Muscles to Paralytic Scoliosis. J. Bone and Joint Surg., XIV, 763, Oct. 1932.

MAYER, LEO: Fixed Paralytic Obliquity of the Pelvis. J. Bone and Joint Surg., XIII, 1, Jan. 1931.

Further Studies of Fixed Paralytic Pelvic Obliquity. J. Bone and Joint Surg., XVIII, 1, Jan. 1936.

THE OBTURATOR SIGN AS THE EARLIEST ROENTGENOGRAPHIC SIGN IN THE DIAGNOSIS OF SEPTIC ARTHRITIS AND TUBERCULOSIS OF THE HIP *

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In the anteroposterior roentgenographic examination of the pelvis and hip, a soft-tissue shadow may be seen just medial to the acetabulum on the inner aspect of the pelvis (Fig. 1). The border of this shadow ordinarily starts from a point lateral to and below the lower pole of the

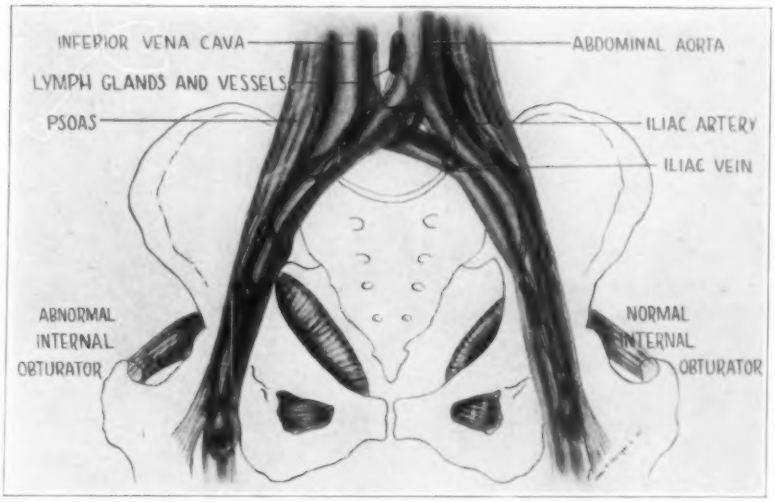

FIG. 1

Anatomical sketch of normal (left) and abnormal (right) obturatores interni and their relationship to pelvic structures.

sacro-iliac joint, follows the line of the pelvic inlet downward over the acetabulum, and disappears behind the upper ramus of the pubis. This shadow in normal children measures from two to eight millimeters at its widest point. Usually the shadow on one side corresponds in width to the shadow on the other. There may be, however, a minimal difference in width of this shadow in normal individuals.

It has been noted that certain changes occur in the contour of this shadow in cases of septic arthritis and in tuberculosis of the hip.

It is the purpose of this study to determine the anatomical basis for this shadow and its importance in the early roentgenographic diagnosis of pathological conditions about the hip.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

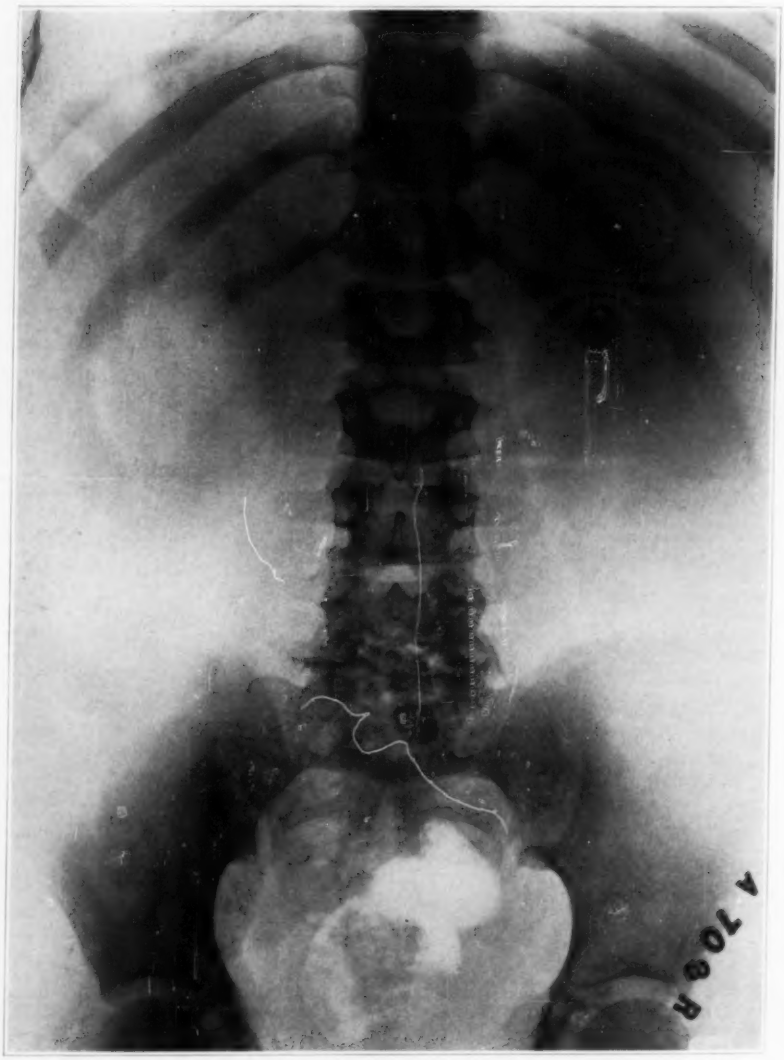

FIG. 2

Tuberculosis of the spine with a partially calcified psoas abscess overlying the obturator shadow on the right (postero-anterior view).

The shadow is not entirely unknown, even though no direct mention of it, as such, could be found in the literature. It has been used by some roentgenologists as one of the early roentgenographic signs of inflammatory diseases of the hip. The authors are not aware of any systematic investigation as to its meaning and diagnostic importance. A rather extensive search of the American literature of the last ten years did not reveal any appreciation of the value of this sign in the early diagnosis of hip disease. Hepler's article deals with a very late stage with abscess and involucrum, while the paper of Freiberg and Perlman mentions an intra-

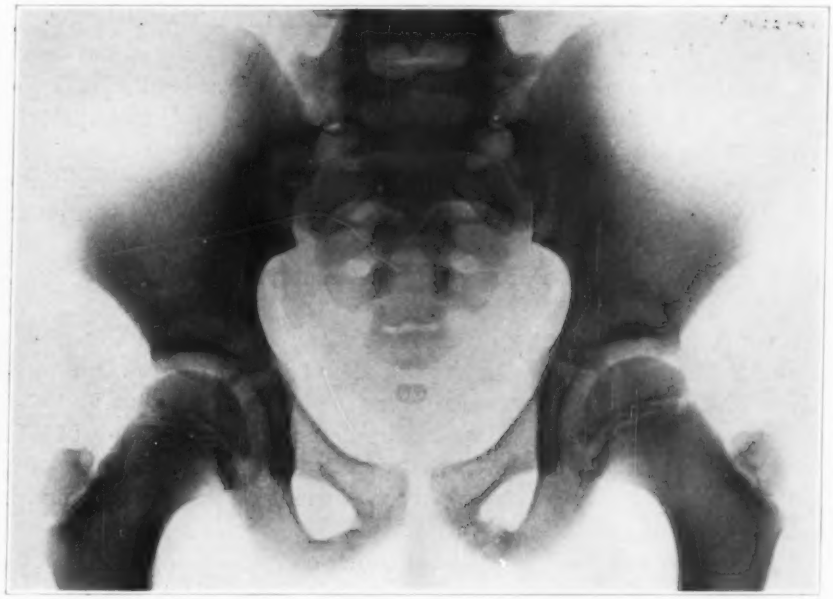

FIG. 3-A
W. L. Normal obturator shadows.

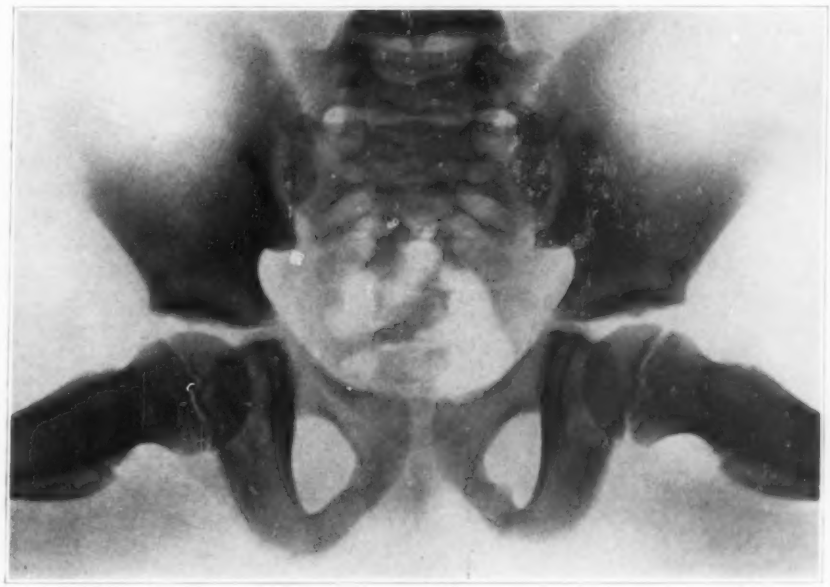

FIG. 3-B
Normal obturator shadows with patient in "frog position".

pelvic soft-tissue shadow which they thought was due to a frank iliac abscess.

ANATOMY

Four structures were considered as possibly involved in the production of this shadow: (1) iliopsoas, (2) intrapelvic lymphatics, (3) capsule of the hip joint, (4) obturator internus.

It is felt that the iliopsoas has been ruled out as the involved structure. Dissection was carried out on a postmortem specimen, so that the fibers of the psoas and iliacus were laid bare. A curved wire was then placed along the inner border of the psoas and an anteroposterior roentgenogram showed that the psoas did not correspond to the shadow described. The psoas was then removed and another roentgenogram was obtained. This showed no change in the shadow. Figure 2 shows a well-defined calcified psoas abscess overlying a normal shadow.

The possibility of lymphadenopathy along the intrapelvic vein being the cause of the shadow was ruled out when ten consecutive cases of infection in the soft tissue about the thigh with inguinal lymphadenopathy showed no change in the shadow.

The position of the lymphatics does not correspond to the position of the shadow as seen in the roentgenogram.

The last possibility is the obturator internus muscle, and the

FIG. 4

J. D. L. March 2, 1940. Septic arthritis of the left hip two weeks after the onset of symptoms. There is slight haziness of the head of the left femur. The border of the obturator shadow is obscure, but can be faintly seen to extend to the edge of the pelvis. The obturator sign is 4 plus.

authors believe this has been definitely proved to be the substratum of the shadow. The fibers of the obturator internus were laid bare in a post-mortem specimen, and a wire was placed along its medial border. This corresponded exactly to the position of the border of the shadow as seen in all the roentgenograms.

PATHOLOGY

The authors have not had an opportunity to determine the intrapelvic pathological changes occurring in cases of septic arthritis of the hip with changes in the obturator internus demonstrable roentgenographically, because no autopsy on such a case has been available.

However, it will be remembered that the tendon of the obturator passes immediately adjacent to the capsule of the hip, and that extension of the inflammatory process may well lead to a roentgenographically visible swelling of the obturator muscle. In far-advanced cases this may represent a true abscess formation; in early cases, only oedema of the muscle. It seems probable that other muscles in close proximity to the hip joint are also involved. This, however, cannot be shown on roentgenograms because of overlying structures. There is no other muscle about the hip which may be roentgenographically differentiated from surrounding soft tissue.

DESCRIPTION OF SIGN

The obturator sign consists in a widening and a change in the contour of the normal obturator shadow as above described. This widening may be from slight to very marked and four gradations, from 1 to 4, have been made more or less arbitrarily. Grade 2 was considered to include those cases in which the shadow was approximately twice the normal width; Grade 4, more than four times the normal; and Grades 1 and 3 were placed correspondingly. In most instances the opposite hip may be taken as the normal.

In a very small number of cases it was noted that the obturator shadow was obscured. It was impossible to determine the border of the shadow because of haziness. After making the study the conclusion was reached that an obscured obturator shadow is a positive finding indicative of hip-joint pathology.

It is believed that the widening, the changes in contour, and the obscurity of the border, may be compared with the well-known changes of the psoas shadow, seen in roentgenographic examination of a psoas abscess, perinephritic abscess, or other inflammatory process overlying, or in contact with, the psoas muscle.

TECHNICAL CONSIDERATIONS

The usual technique for routine anteroposterior roentgenograms of the pelvis is followed. No special advantage has been shown by using

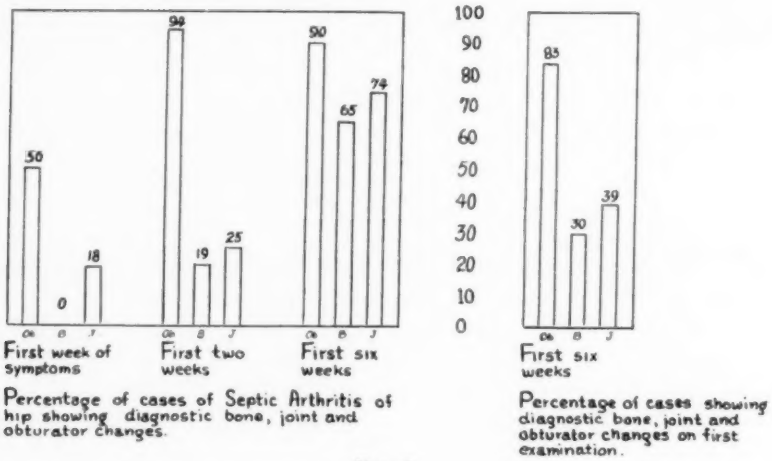

FIG. 5

Note that those seen during the first two weeks include six patients seen during the first week.

soft-tissue technique. Care must be taken that the pelvis is level or one obturator may be thrown into higher relief than the other one.

In some cases it has been advantageous to obtain an anteroposterior view of the pelvis with the hips in marked abduction, flexion to 90 degrees, and marked external rotation (so-called "frog position", frequently used in obtaining lateral views of the hips) which seems to bring the obturator shadow into greater relief.

In a fair number of cases it is found impossible to obtain this position

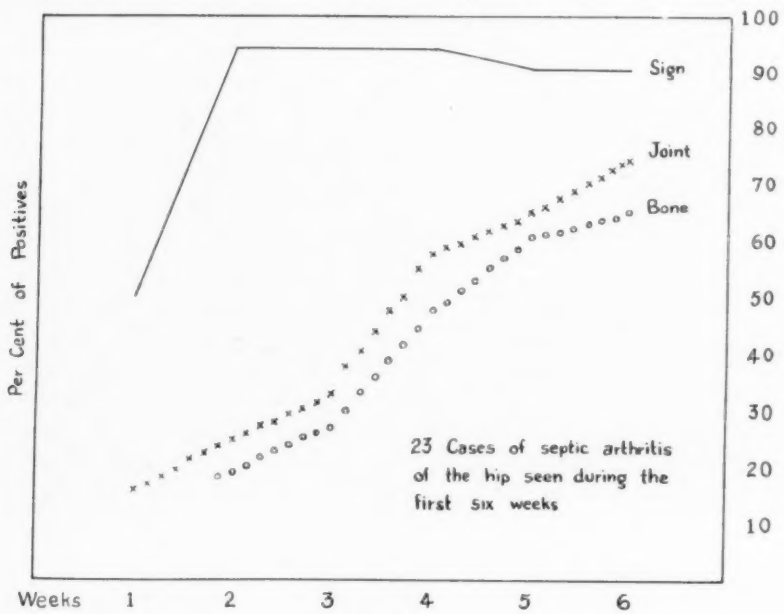

FIG. 6

because of pain and muscle spasm. In all cases it is obligatory that both hips be in the same position if one is to have a basis for comparison.

CLINICAL APPLICATIONS

Septic Arthritis of the Hip

Twenty-three cases of suppurative arthritis of the hip served as the clinical basis for this study. These cases were broken down into groups depending upon the duration of hip symptoms prior to roentgenographic examination, in order that the value of the obturator sign in early hip pathology might be determined. All cases were proved by bacteriological examination, by surgery, or by the clinical course—such as subsequent ankylosis, sequestrum formation, etc.

Six patients were examined by roentgenogram during the first week after the onset of symptoms. Of them, three, or 50 per cent., showed a positive sign; one was classified as Grade 2; and two as Grade 1. None had bone changes; one, or 18 per cent., had joint changes (Fig. 5).

Sixteen patients, including the six seen during the first week, were examined roentgenographically during the first two weeks after the onset of symptoms. All but one of these showed a positive obturator sign. This particular patient died on the ninth day after onset, and it may well be that the overwhelming sepsis became severe enough to cause death before the local conditions could produce the sign. In two cases, the shadow was obscured; in three cases the shadow was classified as Grade 1; in

FIG. 7

E. E. September 26, 1940. Septic arthritis, left hip (staphylococcus aureus). The obturator sign is 2 plus. The first roentgenogram, which was taken three days after onset of symptoms, showed a 1 plus obturator sign, but no bone or joint pathology.

seven cases, as Grade 2; in one case, as Grade 3; in two cases, as Grade 4. Therefore, 94 per cent. of these sixteen cases showed positive changes

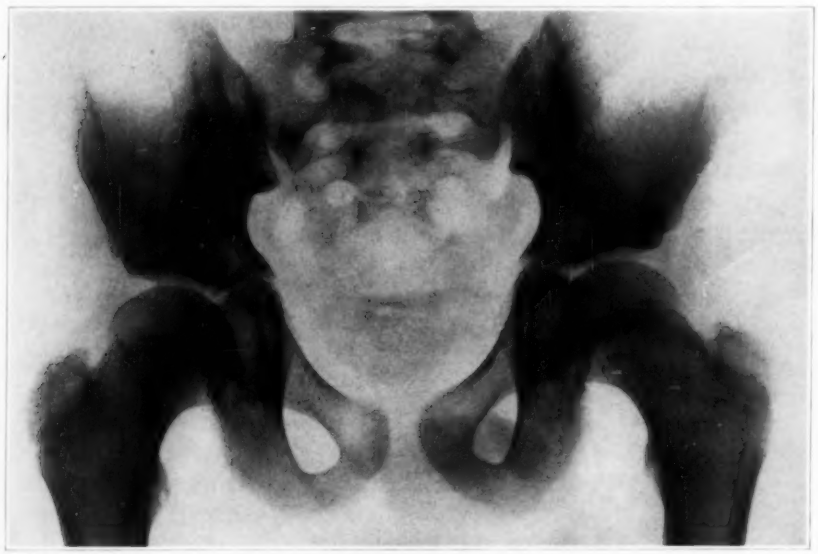

FIG. 8

G. F. May 20, 1941. Septic arthritis of the right hip, eight days after onset of symptoms. No bone or joint change is visible, but the obturator sign is 2 plus. Traction was applied and the patient was given sulfathiazole. He became clinically cured. No bone or joint pathology has yet been observed. The obturator sign became 1 plus.

FIG. 9

E. B. January 9, 1931. Septic arthritis of left hip, three weeks after the onset of symptoms. The obturator sign was 2 plus. It was another two weeks before any bone or joint change was observed.

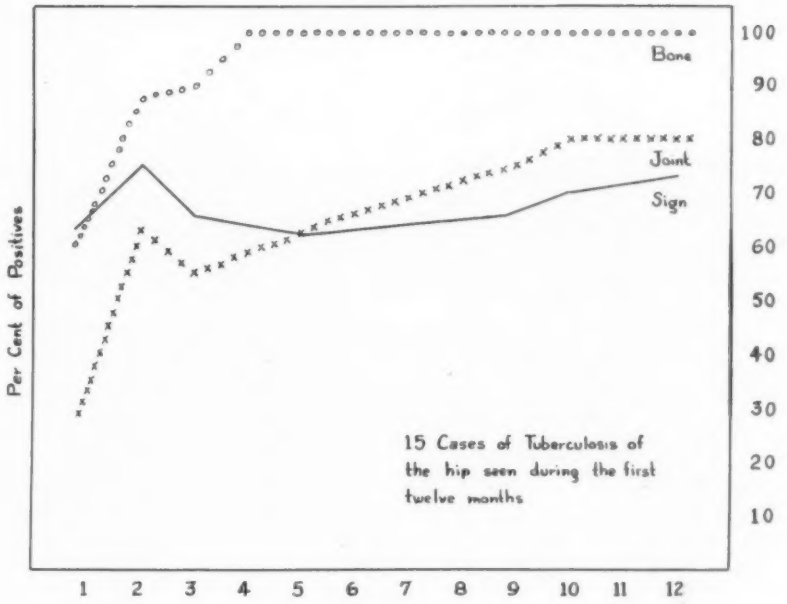

FIG. 10

in the obturator shadow; 19 per cent. showed bone changes; and 25 per cent. showed joint changes (Fig. 5).

Seven additional patients were first examined roentgenographically after the first two weeks of symptoms but before the end of six weeks. All but one of these showed a positive sign. The first roentgenogram of this patient at this Hospital was taken five weeks after the onset of symptoms and one week after surgical incision and drainage of the hip had been done. It has been noted that after incision and drainage, or after the local disease has become quiescent, the sign may become less positive or even negative. Many patients, however, show changes of Grade 2 or 3 for the entire period that they have been followed, which in some instances was more than five years.

Taking into consideration all twenty-three cases seen within a period of six weeks after the onset of symptoms, twenty-one, or 91 per cent., showed a positive obturator sign. The probable reasons for the two negative results were, in one, incision and drainage, and in the other, death by overwhelming sepsis before the sign could become positive.

Bone changes were seen in 65 per cent. before the end of six weeks. Joint changes were seen in 74 per cent. of the cases. There were four patients with positive obturator signs, who, however, showed no bone or joint changes at the end of six weeks. Of these, one was observed for only seventeen days and another for four weeks; both may later have developed bone and joint changes. Two showed joint changes after six weeks.

In fourteen cases the invading organism was determined. Of

these, two were pneumococci, three were hemolytic streptococci, one was staphylococcus albus, and the remaining eight were staphylococcus aureus.

This study showed no appreciable difference in the frequency or time

FIG. 11-A

V. L. July 13, 1940. Tuberculosis of the left hip. Onset of pain occurred about June 24, 1940, and limp was first noted about June 31, 1940. This first roentgenogram shows no bone or joint change although the obturator sign is 2 plus. Mantoux test was 4 plus, and the sedimentation rate was very rapid.

FIG. 11-B

V. L. August 12, 1940. Early bone changes are visible just above the ilio-ischial junction. The obturator sign remains 2 plus.

FIG. 11-C

V. L. March 31, 1941. After surgery the area of destruction continued to enlarge. On February 29, 1941, an extracapsular incision and drainage of the bone abscess were done, and a guinea pig was inoculated. It was reported positive for tuberculosis on April 11, 1941.

of appearance of bone, joint, or obturator-shadow changes for the various infecting organisms.

The obturator sign is of greatest value during the early weeks of hip disease. At the end of the first two weeks it was possible to make a roentgen-ray diagnosis of hip disease in 94 per cent. of the cases, whereas using bone and joint changes alone, the diagnosis could have been made in only 25 per cent. (Fig. 6). The curve for percentage of cases having a positive obturator sign rises sharply from 50 per cent. at the end of the first week to over 90 per cent. The curve was not followed after six weeks.

The curves for percentages of cases with bone and joint changes rise much more slowly, and even at the end of a six-week period do not approach the height of the percentage curve for the obturator sign. The joint changes are considerably more frequent than bone changes.

The obturator sign was first found positive on the third day; joint changes on the fifth; and bone changes on the eighth.

The obturator sign in septic arthritis of the hip is not peculiar to children, but has been observed in adults, although such cases were not included in this study.

Tuberculosis

The onset of tuberculosis of the hip is so much less sudden and dramatic than septic arthritis, that the first roentgenographic examination is

usually made weeks or even months, rather than days, after the onset of symptoms.

The authors' material consisted of seventeen cases of hip tuberculosis, fifteen of which were seen during the first twelve months.

These cases were again divided into two groups, depending upon the duration of symptoms.

The first group consisted of eight patients seen within the first three months. Of these 90 per cent. showed bone changes, 66 per cent. showed obturator changes, and 55 per cent. showed joint changes.

Fifteen patients were observed during the first twelve months, and of these 100 per cent. showed changes in the bones of the hip joint, 80 per cent. showed joint changes, and 73 per cent. showed obturator changes. Eighty-seven per cent. showed bone changes at the first examination, 66 per cent. joint changes, and 73 per cent. obturator changes.

Of the seventeen cases observed during the first twenty-four months 100 per cent. showed bone changes, 88 per cent. joint changes, and 76 per cent. obturator changes.

It was noted that in tuberculosis of the hip, the obturator shadow was most frequently obscured, rather than showing a distinct bulging with sharply demarcated border, as is usually seen in septic arthritis. This may be compared to the loss of visibility of the psoas shadow in the roentgenogram in tuberculosis of the spine. The obscured obturator shadow in hip tuberculosis is a positive finding.

It is obvious that the obturator sign is of no great value in making a diagnosis of early tuberculosis of the hip, inasmuch as both the bone and joint changes usually appear earlier and with greater frequency. However, in one of the authors' cases (Figs. 11-A, 11-B, and 11-C), the obturator sign was of value. In this case it became positive four weeks before either bone or joint change. It may be that if roentgenograms were available very early in tuberculosis of the hip joint, the obturator sign might prove to be of more importance than shown in these cases.

It is to be noted that in this small series, bone changes appeared earlier and with greater frequency than joint changes. This is contrary to the generally accepted view that joint change is the first sign of hip tuberculosis.

Other Pathological Conditions of the Hip Studied

1. *Perthes' Disease.* The roentgenograms of twenty cases of Perthes' disease in all stages, early and late, were reviewed, and in no instance was any change in the obturator shadow noted.

2. *Epiphysiolysis (Slipping of the Capital Epiphysis).* Seven cases of epiphysiolysis of varying degree were observed with a normal obturator sign.

3. *Rheumatic Fever with Clinical Involvement of the Hip.* Six cases of rheumatic fever with clinical involvement of the hip were studied, and the obturator shadow was normal throughout.

4. *Fracture about the Hip.* In ten cases of fracture of the pelvis, ischium, ilium, and femur close to the hip joint, no pathological change in the obturator outline was evident.

5. *Osteomyelitis of the Pelvis Not Involving or Neighboring the Hip Joint.* Six cases of this type were studied, and again no obturator involvement was noted.

6. *Soft-Tissue Infection about the Thigh with Marked Inguinal Lymphadenopathy.* Ten such cases presented an entirely normal appearance of the obturator shadow.

SUMMARY

1. The normal appearance of the obturator shadow is described.

2. In certain types of hip pathology the obturator shadow becomes obscured, or it becomes widened with a more curved border. This is called a positive obturator sign.

3. The greatest value of this sign is in the early roentgenographic diagnosis of septic hip disease.

4. It is of some importance in the early diagnosis of tuberculosis of the hip.

5. It is not present in fractures about the hip, osteochondritis, and other pathological conditions of the hip.

REFERENCES

HEPLER, A. B.: Bladder Displacement Secondary to Suppurative Arthritis of the Hip and Osteomyelitis of the Pelvic Bones in Children: Operation for Impending Perforation. J. Urology, XXXV, 32, 1936.

FREIBERG, J. A., AND PERLMAN, ROBERT: Pelvic Abscesses Associated with Acute Purulent Infection of the Hip Joint. J. Bone and Joint Surg., XVIII, 417, Apr. 1936.

ELONGATION OF THE HEEL FOR CALCANEUS DEFORMITY

BY HENRY MILCH, M.D., NEW YORK, N. Y.

Astragalectomy, advocated by Whitman, has become established as a standard procedure in the treatment of paralytic pes calcaneovalgus. From the point of view of the physiology of the foot, this procedure accomplishes two separate purposes: (1) It eliminates the subastragalar joint in which the valgus deformity develops; and (2) it tends to equalize the length of the hind foot relative to the forefoot, and so compensates for the muscle imbalance which causes the calcaneus. The latter objective, achieved by displacing the foot backward under the axis of rotation at the ankle joint, serves to shorten the anterior lever arm upon which the dorsal extensors act, and to lengthen the posterior lever arm upon which the plantar flexors act. Since the work accomplished by a muscle group is equivalent to its muscle force multiplied by the length of the lever arm through which it is applied, the increased distance of the Achilles tendon from its axis of rotation tends to magnify its effective power, and so to restore the distorted muscle balance between the flexors and extensors of the foot.

Though the success of astragalectomy in cases of complete paralysis is a tribute to the genius of Royal Whitman, it may appear somewhat radical in milder cases of paresis of the Achilles tendon. In such event it seemed reasonable to hope that the actual elongation of the os calcis might serve to lengthen the lever arm, and so restore balance without sacrificing the subastragalar joint. The satisfactory result obtained in the following case prompts its report.

Walter K., aged four, was first seen in April 1935. Born at full term, after a difficult delivery, the child apparently suffered a cerebral insult with a consequent mild right spastic hemiplegia. It was noticed when the child began to walk, that the heel could not be brought to the floor. Physiotherapy and stretching of the Achilles tendon had been attempted at another hospital, but this gave only slight improvement, and a marked contracture was still present upon admission to the Hospital for Joint Diseases.

On May 23, 1935, a Z-shaped lengthening of the right Achilles tendon was performed, and the leg was encased in plaster. On July 3 the plaster was removed. The wound had healed *per primam*. There was active power of flexion and extension at the ankle joint. Physiotherapy was instituted, and the patient was permitted to begin walking. Toward the end of July 1935, the child showed a definite tendency toward a calcaneus type of gait. To overcome this the heel was elevated, and for a time it was hoped that this might suffice. By November it was decided that this hope was futile, and more radical treatment came under consideration.

It was apparent that, as a result of the Achilles lengthening, the plantar flexors had been weakened and the muscle balance disturbed in favor of the dorsal extensors of the foot. Correction by shortening of the Achilles tendon seemed to be indicated. However it seemed desirable to test the validity of a different concept,—that of magnifying the strength

of the existing Achilles musculature by increasing the length of the lever arm through which its force was applied.

With this object the patient was operated upon on November 21, 1935. A curved incision, three inches long, was made along the outer aspect of the Achilles tendon, and around the lower end of the fibula. The Achilles tendon was exposed, and was followed down to its attachment into the os calcis. The upper surface of the calcaneus was exposed, and a large osteotome was driven through the posterior end of the bone, parallel to the attachment of the Achilles tendon. The posterior portion was then turned down, opening up a V-shaped wedge in the tuberosity of the os calcis. This space was filled

FIG. 1

January 20, 1936. Roentgenogram taken after operation. The site of the osteotomy of the os calcis may be seen. The distance from the axis of motion in the ankle joint to the attachment of the Achilles tendon has been increased.

FIG. 2

October 26, 1940. The site of the earlier osteotomy may still be recognized. The proportions of the os calcis are relatively normal, but the epiphysis of the os calcis is on the *postero-inferior*, instead of on the posterior aspect of the os calcis.

with fragments of bone removed from the tibia. As a consequence of this, the posterior projection of the os calcis and the distance of the Achilles tendon from its center of rotation at the ankle joint were increased. The insertion of the Achilles tendon was thus displaced downward, so that it pointed plantarward, instead of backward. Some difficulty was experienced in closing the skin wound, because of the increase in the length of the os calcis. A plaster-of-Paris boot was applied, with the foot in slight equinus and the knee at right angles. Three days later the patient was discharged to the Out-Patient Department.

On January 8, 1936, the plaster was removed, the wound was found healed, and physiotherapy was begun. In May 1936, marked improvement in the patient's gait was noted. Reexamination in June 1941 disclosed apparently normal proportions of the heel. The motions of the foot were excellent, and the patient manifested good power in the Achilles tendon when walking or running. There was no evidence of either an equinus or a calcaneus deformity of the heel, but there appeared to be a mild cavus, due to the dropping of the forefoot.

The restoration of balance obtained seemed to be due mainly to the increased length of the posterior lever arm to which the Achilles tendon was attached. In the author's own mind, it seemed to stress the fact that the work done by a muscle group may be influenced, either by modifying the length of the muscle itself, or by altering the length of the lever arm upon which the intrinsic muscle power is applied. It suggested another method of reestablishing muscle balance in certain cases of mild flaccid paralysis, where the possibility of modifying the intrinsic power of the muscles is precluded.

CALCIFICATION AND OSSIFICATION OF THE MENISCI *

BY JAMES B. WEAVER, M.D., KANSAS CITY, MISSOURI

From the University of Kansas Hospitals, Kansas City, Kansas

CALCIFICATION

Calcification of the menisci of the knee joint has received scant attention in the American literature. The author wishes, therefore, to record the following two cases.

CASE 1. A man, forty-seven years of age, was admitted to the Hospital, suffering from a severe attack of asthma of eight weeks' duration. Orthopaedic consultation was requested because of pain and oedema of the right knee and ankle.

The patient's first asthmatic attack had occurred two years previously, and he had been treated in another hospital for six weeks. During that time he had had pain and oedema of the right knee, which cleared up quite promptly under diathermy and infra-red-heat treatments. In the two-year interim he had had only mild asthmatic symptoms and no particular trouble with the knee. The patient stated that during childhood he had run a hedge thorn into the right knee. The thorn was said not to have been recovered and roentgenograms taken at the age of thirty-five years were said to have shown that the thorn had "turned to stone". The presence of the thorn, according to the patient, had always caused weakness of the knee.

Examination showed marked hydrops of the right knee. There was some increased heat, but the knee was not very tender. Redness, swelling, and increased heat were noted about the ankle, which was moderately tender. About 200 cubic centimeters of straw-colored fluid was aspirated from the knee joint. This fluid was sterile for bacterial growth.

Roentgenograms of the right knee (Fig. 1-A) showed calcification of both menisci. The left knee and both ankles were thereafter x-rayed. Both menisci of the left knee, in which no symptoms had ever been present, were seen to be also calcified (Fig. 1-B). The roentgenograms of the ankles were negative for abnormalities.

Diathermy treatments were instituted, and in ten days there was complete relief of symptoms. There had been no recurrence when he was discharged from the Hospital two weeks later. The subsequent course is not known.

CASE 2. † A man, fifty-five years of age, was admitted to the Hospital because of arthritis of multiple joints of several years' standing. He had pain in the shoulders, back, knees, feet, and ankles. Roentgenographic examination of these parts showed hypertrophic changes. Calcified menisci were apparent in the roentgenograms of the knees (Figs. 2-A and 2-B), and the lumbar intervertebral discs were also calcified.

In addition to these two cases, reports of seventy-six others have been found in the literature, making a total of seventy-eight reported cases (Table I). A case report by Beiler was found to have been previously reported by W. Schwarz and is not included in this series.

In addition to the seventy-eight cases in Table I, Mandl, in the histological examination of menisci from thirty-eight patients who had been operated upon, found fourteen cases of calcification not due to trauma.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

† From the U. S. Veterans Administration Hospital, Wadsworth, Kansas, through the courtesy of C. B. Francisco, M.D.

Tobler examined the menisci taken at autopsy in 1000 cases and at operation in 400 cases, and found histological evidence of calcium in 30 per cent. of older individuals. Bircher found three cases of calcification out of 100 in which he made microscopic examinations. Wolke, Müller, Andreesen, Wagner, and Eck examined a total of 12,268 roentgenograms of knees, and found that fifty-two, or 0.42 per cent., showed calcium in the menisci. From the foregoing evidence it would seem that calcification of semilunar

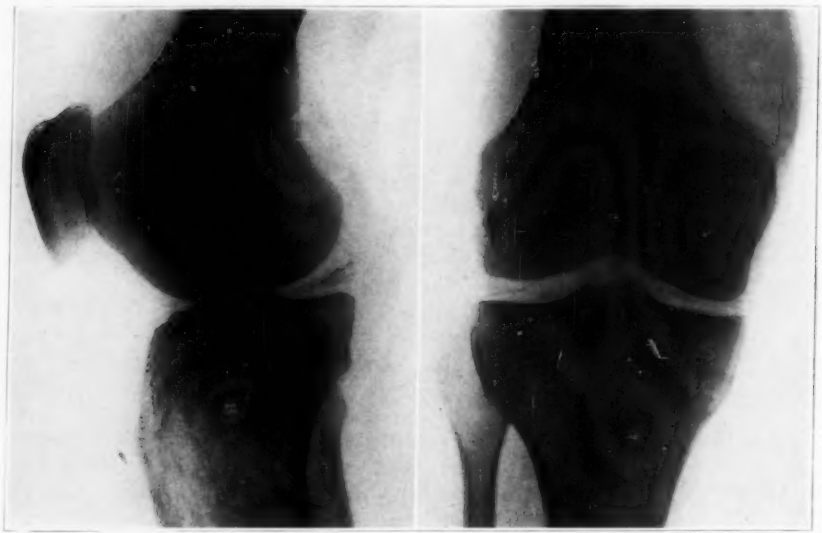

FIG. 1-A

Case 1. Right knee.

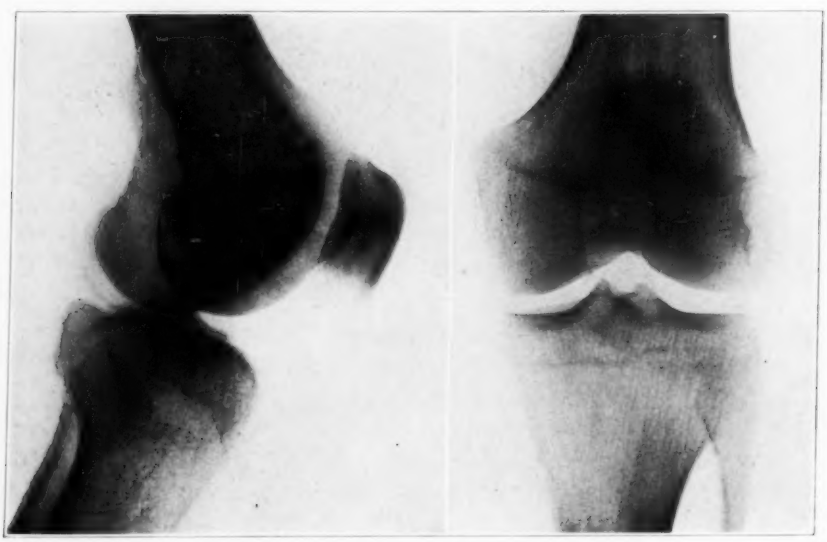

FIG. 1-B

Case 1. Left knee.

FIG. 2-A
Case 2. Right knee.

FIG. 2-B
Case 2. Left knee.

TABLE I

CALCIFICATION OF THE MENISCI

Author	Year	Primary (Non-Traumatic) *No. of Cases*	Secondary (Traumatic) *No. of Cases*
Andreesen	1933	4	9
Backmund	1933	1	0
Balensweig and Bosworth	1937	2	0
Bruchholz	1929	1	0
Eck	1939	0	15*
Fabbro	1939	3	2
Fründ	1926	0	1
Henrichsen	1932	0	1
Hilgenreiner	1932	0	1
Israelski and Pollack	1930	3	0
Massabuau, Guibal, Joyeux, et Rodier	1939	0	1
Meyer-Borstel	1931	1	0
Müller	1933	2	0
Paltrinieri	1937	1	0
Rubaschow	1929	0	1
Schapiro	1931	0	1
Schwartz, E.	1930	1	0
Schwarz, W.	1932	1	0
Sommer	1929	1	1
Sonntag	1928	1	0
Wagner	1933	10	2
Weaver	1942	2	0
Werwath	1928	1	0
Wolke	1935	8	0
Total		43	35

* Eck reported 16 cases. The author has listed one of these cases as secondary ossification, as the affected cartilage contained bone, and was very similar to the author's Case 3.

cartilages (menisci), while not a common finding, can hardly be classified as a rarity.

Primary and secondary calcification in menisci are two separate and distinct entities that have little in common except the presence of calcium. Mandl was the first to differentiate between a primary, or non-traumatic, and a secondary, or traumatic, type of calcification. Fründ, in 1926, was the first to publish a roentgenogram showing the secondary type, the presence of which he had verified at operation. In 1928, Werwath published the first roentgenogram of the primary type with a report of operative verification, although Mandl had previously described the histological picture of such menisci.

The following observations on these two types are based on the data furnished by the authors listed in Table I.

Incidence: The ratio of forty-three primary to thirty-five secondary

cases (Table I) is considered to be not a true picture. Many case histories were very scanty, and the author feels that some cases listed as secondary were, as a matter of fact, primary. If the cases of Mandl, Tobler, and Bircher had been included in the primary list, the ratio would be much greater. Then, too, many patients with primary calcification have no complaints and, therefore, their cases are not deemed of sufficient interest for publication. The opposite is true of the secondary type.

Age: The primary type occurs in older individuals. The youngest patient whose case was reported was thirty-two years of age, and he was the only one under forty years of age. Four were under fifty years and the remainder were over fifty years of age, many being over seventy years. The secondary type occurs in younger individuals. Fully 80 per cent. of the patients were in the third decade of life. The youngest was eighteen years of age.

Sex: There was a preponderance of males in both types.

Cartilage Affected: Both menisci of both knees were affected in cases of the primary type, but only one meniscus in each knee was affected in cases of the secondary type.

Deposition of Calcium: In the primary cases, the calcium is laid down in parallel layers, starting at the periphery of the cartilage and involving the entire length. The meniscus is smooth. The secondary cases show a localized zone of calcification, usually in one end or the other, and of the central type. This calcium piles up, causing a roughening and enlargement of the part of the cartilage affected.

Roentgenographic Appearance: The primary type shows a waferlike aspect of the cartilage in the anteroposterior view and wedge-shaped shadows at each end of the meniscus in the lateral view. This suggests a diffuse calcification of all four menisci, although these areas may vary in size and density according to the age of the lesion. Calcification may be revealed in individual menisci at various times in the same patient. The roentgenographic appearance is characteristic and diagnostic. The secondary type shows a localized piling up of calcium, rough in outline, which might be confused with a joint mouse or ossification in the cartilage. The picture is not diagnostic.

Symptoms: In many instances primary calcification produces no symptoms. Some cases were discovered by accident. Many patients had symptoms in one knee only, but had calcified menisci in both knees, as in Case 1. In some cases complaints were severe enough to necessitate the removal of the cartilage. Symptoms were pain, swelling, limitation of motion, and, at times, hydrops. Pain, swelling, and limitation of motion were the principal symptoms of the secondary type. These quite universally progressed to such severity that removal of the cartilage was necessary.

Complications: Hypertrophic arthritis, both in the affected joints and in other joints, was almost a constant finding in the primary cases. Calcification of intervertebral discs, as well as calcification of other struc-

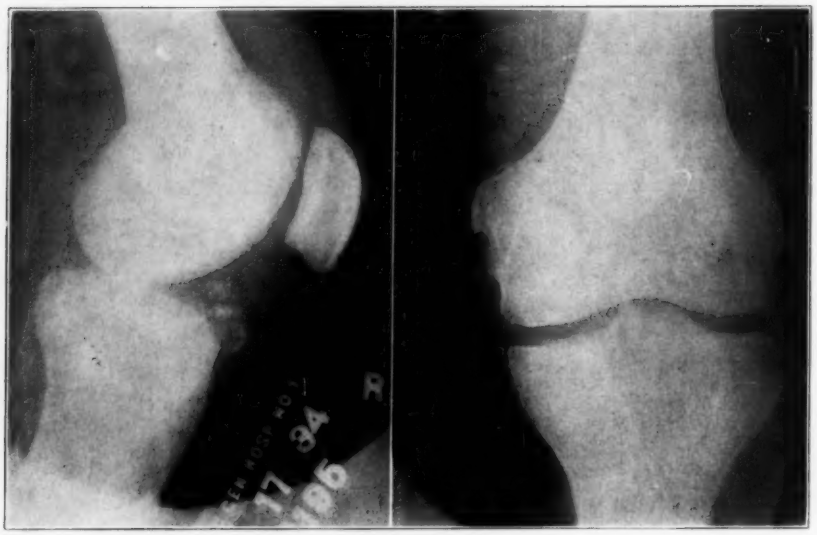

FIG. 3-A

Case 3. Right knee, before operation.

FIG. 3-B

Case 3. Photograph of the pathological specimen.

tures, was a frequent finding. Wolke described plaques of calcium in the articular cartilages in some of his patients. Diabetes, chronic nephritis, gout, asthma, *et cetera*, were also reported as complications, but their significance is questionable. No particular complications were noted in the secondary type, although joint mice were found in four instances.

Etiology: The etiology of primary calcification is unknown, but the condition is considered to be the result of nutritional deficiency due to advanced age. The secondary type is, of course, thought to be the result of trauma. This trauma was severe in all instances, and was caused either by a direct blow or by twisting. Andreesen reported six cases of luxation of the internal semilunar cartilage, all of which showed calcifica-

tion in the detached portion of the meniscus. In eleven of Eck's cases partial or complete luxation of the medial meniscus was present.

Treatment: In the primary type, the treatment is symptomatic. Excision of cartilage is infrequently necessary. Spontaneous cures were numerous. Extirpation is always necessary in the secondary type.

OSSIFICATION

Ossification of the semilunar cartilage is a condition closely allied to calcification of the cartilage and may be a sequela to calcification. The author reported the following case in 1935.

CASE 3. A male, aged twenty-four years, while riding a horse, sustained an injury to the right knee, when it was jammed against a fence. Thereafter, the patient complained of progressive pain, oedema, and limitation of motion, which finally incapacitated him. Roentgenographic examination (Fig. 3-A) revealed calcareous deposits. The affected cartilage was removed twenty months after the injury. Histological examination showed in one portion calcified areas associated with beginning bone formation. In other areas there was cartilaginous tissue in which secondary calcification was occurring and in which bone formation could be recognized. (See Figure 3-C.)

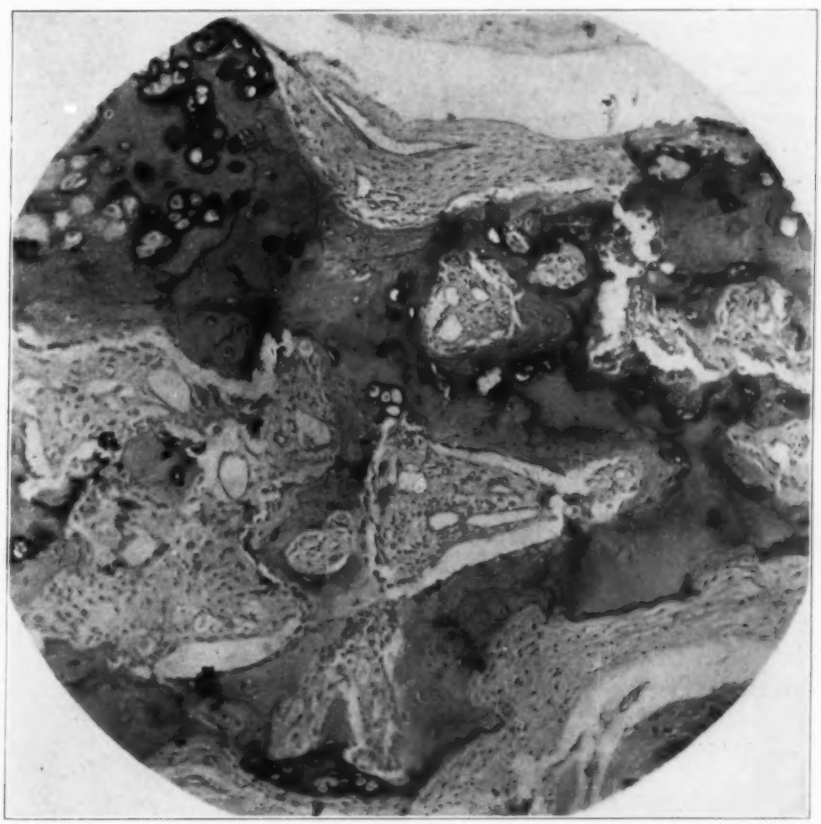

FIG. 3-C

Case 3. Photomicrograph showing new bone and calcium in the meniscus.

Reports of other cases of ossification found in the literature are listed in Table II. Wollenberg was apparently the first to describe this condition. Most of these cases were secondary or traumatic in nature. The primary cases listed are of interest, but are considered to be of minor importance.

The symptoms, roentgenographic appearance, and treatment of secondary ossification of semilunar cartilages are practically the same as in secondary calcification. The question therefore arises as to whether secondary calcification is a precursor of secondary ossification. Certainly no evidence was found that primary calcification is a precursor of ossification. Harris, from anatomical studies, deduced that calcium might form on the surface of semilunar cartilage due to senile changes (primary), but both calcium and bone could form in the central portions, provided a zone of mucoid, fatty, or hyaline degeneration was present (secondary). Calcium, as well as bone, was found in the cases reported by Wollenberg, Eck, and Weaver, but not in the other secondary cases reported in Table II. It seems quite certain that secondary calcification does progress to ossification, but apparently does so in only a small percentage of the cases. Whether or not, in the cases of ossification with no calcium present, there had been calcium at an earlier date is problematical. Watson-Jones and Roberts, and Burrows thought it probable that calcium had been present in their cases, and that they were dealing with a true example of heterotopic bone formation according to the theory of Leriche and Policard. The main steps in this theory are:

1. Formation of the ossifiable medium. This is brought about by the degeneration of the connective tissue to an embryonic state due to traumatic or infectious inflammation.

2. Calcium deposition and its resorption. All heterotopic ossification takes place in the vicinity of a calcified deposit at the point of phosphocalcific concentration.

3. Formation of heterotopic ossification. When an embryonic con-

TABLE II

OSSIFICATION OF THE MENISCI

Author	Year	Primary (Non-Traumatic) *No. of Cases*	Secondary (Traumatic) *No. of Cases*
Burrows	1934	0	2
Eck	1939	0	1
Giraudi e Carnevali	1933	1	0
Tobler	1933	1	1
Watson-Jones and Roberts	1934	0	2
Weaver	1935	0	1
Wollenberg	1931	0	1
Total		2	8

nective tissue which has become ossifiable and a collection of calcium are brought together by chance, ossification takes place by the usual processes.

The cases of secondary ossification reported by Wollenberg, Eck, and Weaver are unquestionably true examples of heterotopic bone formation, and the other cases are probably in the same category. The author is of the opinion that many cases of secondary calcification do not progress to ossification, and that those of primary calcification very rarely, if ever, do.

REFERENCES

Andreesen, Remmer: Über Verkalkung der Knorpelzwischenscheiben der Kniegelenke. Beitr. z. Klin. Chir., CLVIII, 75, 1933.

Backmund, Karlheinz: Meniskusverkalkung (Primäre Meniskopathie). Röntgen-Praxis, V, 815, 1933.

Balensweig, Irvin, and Bosworth, D. M.: Calcification of the Semilunar Cartilages of the Knee Joint. Surgery, II, 120, 1937.

Beiler, Karl-Heinz: Meniscusverkalkung beider Kniegelenke auf nichttraumatischer Grundlage (Primäre Meniskopathie). Monatschr. f. Unfallh., III, 118, 1933.

Bircher, Eugen: Die Binnenverletzungen des Kniegelenkes. Schweizerische Med. Wchnschr., X, 1309, 1929.

Bruchholz, H.: Knie-Meniskusverkalkung im Röntgenbild. Röntgen-Praxis, I, 888, 1929.

Burrows, H. J.: Two Cases of Ossification in the Internal Semilunar Cartilage. British J. Surg., XXI, 404, 1934.

Eck, T.: Meniscusverkalkungen und ihre Differentialdiagnose. Chirurg., XI, 547, 1929.

Fabbro, G.: La calcificazione dei menischi articolari del ginocchio. Gior. Med. d. Alto Adegi, XI, 569, 1939.

Fründ: Diskus- und Meniscuserkrankungen verschiedener Gelenk. Zentralbl. f. Chir., LIII, 2987, 1926.

Giraudi, Gioffredo, e Carnevali, S. L.: Sulla "ossidesmosi ipertrofica" e sui processi di ossificazione e di calcificazione dei menischi del Ginocchio. Arch. di Ortop., XL, 1083, 1933.

Harris, H. A.: Calcification and Ossification in the Semilunar Cartilages. Lancet, I, 1114, 1934.

Henrichsen, A.: Meniskusverkalkung im Röntgenbild (Primäre Meniskopathie). Röntgen-Praxis, IV, 403, 1932.

Hilgenreiner, H.: Wann ist der Kniegelenksmeniscus im Röntgenbilde darstellbar? Zentralbl. f. Chir., LIX, 405, 1932.

Israelski, Martin, und Pollack, Herbert: Über Kalkablagerungen in den Kniegelenken und Intervertebralscheiben. Beitr. z. Klin. Chir., CL, 476, 1930.

Leriche, R., and Policard, A.: The Normal and Pathological Physiology of Bone. Authorized English translation by Sherwood Moore and J. Albert Key. St. Louis, C. V. Mosby Co., 1928.

Mandl, Felix: Zur Pathologie und Therapie der Zwischenknorpelerkrankungen des Kniegelenkes. Arch. f. Klin. Chir., CXLVI, 149, 1927.

Massabuau; Guibal; Joyeux; et Rodier: Un cas de calcification du ménisque interne du genou. Arch. Soc. d. Sc. Méd. et Biol. de Montpellier, XX, 241, 1939.

Meyer-Borstel, H.: Meniscusverkalkungen. Chirurg., III, 424, 1931.

Müller, P.: Über Meniskusverkalkung im Kniegelenk. Zentralbl. f. Chir., LX, 2055, 1933.

Paltrinieri, Mario: Analogie fra degenerazione del disco intervertebrale e meniscite del Ginocchio. Chir. d. Org. di Movimento, XXIII, 161, 1937.

Pearson, Karl, and Davin, A. G.: On the Sesamoids of the Knee-Joint. Part I. Man. Biometrika, XIII, 133, 1921.

RUBASCHOW, S.: Der Kniegelenksmeniscus im Röntgenbilde. Zentralbl. f. Chir., LVI, 3268, 1929.

SCHAPIRO, M.: Wenn man einen Kniegelenksmeniscus im Röntgenbild zu sehen bekommt. Zentralbl. f. Chir., LVIII, 1436, 1931.

SCHWARTZ, EUGEN: Ein neuer Fall von primärer Meniskopathie. Röntgen-Praxis, II, 380, 1930.

SCHWARZ, WALTHER: Ein weiterer Fall von doppelseitiger Meniskusverkalkung im Röntgenbild (Primäre Meniskopathie). Röntgen-Praxis, IV, 751, 1932.

SOMMER, RENÉ: Meniscusschäden im Kniegelenk. Ergebn. d. Chir. u. Orthop., XXII, 387, 1929.

SONNTAG: (Tagung der Vereinigung mitteldeutscher Chirurgen 1928, S. 2903.) Zentralbl. f. Chir., LV, 2932, 1928.

TOBLER, TH.: Zur normalen und pathologischen Histologie des Kniegelenkmeniscus. Arch. f. Klin. Chir., CLXXVII, 483, 1933.

WAGNER, W.: Über Meniskusverkalkungen. Röntgen-Praxis, V, 188, 1933.

WATSON-JONES, R., AND ROBERTS, R. E.: Calcification, Decalcification, and Ossification. British J. Surg., XXI, 461, 1934.

WEAVER, J. B.: Ossification of the Internal Semilunar Cartilage. J. Bone and Joint. Surg., XVII, 195, Jan. 1935.

WERWATH, KURT: Abnorme Kalkablagerungen innerhalb des Kniegelenkes, ein Beitrag sur Frage der primären "Meniskopathie". Fortschr. a. d. Geb. d. Röntgenstrahlen, XXXVII, 169, 1928.

WOLKE, KNUT: Über Meniskus- und Gelenkknorpelverkalkungen. Acta Radiol., XVI, 577, 1935.

WOLLENBERG, G. A.: Zur Differentialdiagnose der Meniskusverletzungen und Gelenkmäuse. Ztschr. f. Orthop. Chir., LV, 402, 1931.

ARTHRODESIS OF THE WRIST WITH THE USE OF GRAFTS OF CANCELLOUS BONE *†

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For the improvement of function in disabilities which occur in the upper extremity, one of the most valuable procedures is arthrodesis of the wrist. In postpoliomyelitic paralysis of the hand and forearm, the operation is comparable in value with stabilization of the foot when the lower extremity is involved. It can also be employed with great benefit in paralysis of the spastic type and in Erb's palsy, or when permanent damage has occurred either to the brachial plexus or to the peripheral nerves of the arm. Furthermore, it is effective in the treatment of painful wrists due to arthritis of either traumatic or infectious origin. This important procedure, therefore, demands a method of operation which will ensure certain and rapid fusion of the joint. Such a method, with the use of cancellous bone as a grafting material, has been employed by the writers for more than twenty years. The technique is simple and yields eminently satisfactory results.

A careful review of the literature shows that a wide variety of methods have been described for stabilization of the wrist, among which, in early works, is the bizarre use of heteroplastic bone grafts from the dog (Dubar, 1897). Steindler described the open-wedge operation in 1918 and reported the results of twenty-five cases in 1921. In 1920, Ely presented his technique with the use of a tibial graft in cases of tuberculosis of the wrist. Scherb (1927) used a graft from the upper end of the femur which, because of its concavity, could be fitted to the surfaces of the wrist joint. Liebolt (1938) reported forty-four cases. He considered small bone chips better than large bone grafts, because the former revitalized more quickly than the latter. Bone chips were obtained from different parts of the skeleton, usually from the distal end of the radius. Cartilage was removed from each carpal bone to be fused and portions of these bones were broken down into chips. When these sources were insufficient, the ilium or tibia was used. Liebolt believed that the ideal position for function of the ankylosed wrist was 25 to 30 degrees of extension and the neutral lateral position.

In 1940, Smith-Petersen reported a method for arthrodesis of the wrist, and described a new approach to the wrist joint. The incision

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started two or two and one-half inches above the ulnar styloid, ran parallel with the ulna to a point just distal to the styloid, and then curved anteriorly in the direction of the proximal end of the fifth metacarpal. The distal portion ran parallel with this bone for a distance of approximately one inch. A bayonet incision of this type resulted in two flaps which were easily retracted.

The ulnar periosteum was exposed and incised. Following an oblique osteotomy, the distal inch or so of the ulna was removed, exposing the ulnar aspect of the radius. The capsule and ligaments were reflected from the radius along with the periosteum of the latter, exposing the radiocarpal joint. The same procedure was carried out distally, reflecting capsule and ligaments from the carpus. With the hand in the position of dorsiflexion, slots were cut in the radius and the carpus, into which the graft was sunk. As a rule, the excised portion of the ulna, properly shaped, made an efficient graft; the remaining fragments were packed around its volar aspect.

As far as can be determined from this review, no method has been described which is similar to the one herein reported.

SURGICAL AND FUNCTIONAL ANATOMY OF THE WRIST

From the functional point of view it should be borne in mind that it is the unity of interrelated action of the several joints of the upper extremity, which gives to the hand and wrist its synchronized grace and ease of movement. It is therefore necessary for the surgeon to consider for a moment the extent of this characteristic before applying procedures which will disrupt the close association of joints, if he is to preserve the maximum function commensurate with his therapeutic aim.

The region of the wrist is a complex of several joints, the function of which is to give to the hand its great range and versatility of action. The complex consists of the radio-ulnar, the radiocarpal, the several intercarpal, the transverse intercarpal, the carpometacarpal, and intermetacarpal joints.

As is well known, the distal, together with the proximal, radio-ulnar joints primarily provide a mechanism which permits the movements of pronation and supination about the longitudinal axis of the ulna. It is commonly, but incorrectly, taught that the center of rotation in these movements lies at the base of the ulna styloid, corresponding to the point of attachment of the triangular articular disc. It can be demonstrated, however, that this is not the case, but that the center of rotation passes through the center of the head of the ulna. This fact indicates that the ulna is not absolutely fixed during these motions, but that some anteroposterior movement of its head is permitted.

Besides the movements of rotation, the authors have been able to demonstrate an important upward and downward, or pistonlike, movement of the radius on the ulna. This movement is the mechanism which ensures the maintenance of the relation of the radius to the ulna at the

wrist joint during movements of rotation of the forearm, and on flexion and extension of the elbow. This piston movement is a necessary one, allowing for adjustments between the radius and the ulna, because of the pathway, convex to the ulnar side, through which the forearm passes from extension to flexion. Without it the radius would become relatively too short with each movement of flexion at the elbow. Morphological provisions for the piston movement are seen in the extension of the articular surface of the proximal end of the radius onto the ulnar side of its neck, in a similar extension of the articular surface on the radial side of the head of the ulna, and in the forward projection of the capitellum of the humerus. The not infrequent clinical finding of pain and weakness at the wrist following injuries to the lower humerus is no doubt due to a derangement of this piston movement which, by upsetting the relationship of the ulna and the radius at their distal extremities, impedes the smooth action of the wrist. Such a derangement emphasizes the importance of maintaining, as far as possible, the forward position of the distal articular surfaces after intracondylar and supracondylar fractures of the humerus.

In addition, it should be pointed out, with respect to the radio-ulnar joints, that at a point approximately half-way between pronation and supination, the articular surfaces are in greatest congruence, and establish a virtual synarthrosis between the bones, thus defining this as the position of greatest stability.

The movements at the wrist itself occur at the radiocarpal and intercarpal joints and the compound joint between the proximal and distal row of carpal bones, which is termed for convenience the transverse intercarpal joint. There is a tendency to look upon the wrist joint as a simple hinge allowing flexion and extension, and permitting radial and ulnar deviation of the hand. In point of fact, however, the movements are exceedingly complex, and only a brief summary of the main points will be given here.

Flexion, from the mid-position at the wrist, occurs mainly at both the wrist joint proper (radiocarpal joint) and the transverse intercarpal. The greater part of this movement takes place at the transverse intercarpal joint, and, in consequence, intercarpal lesions lead to greater disability in flexion than do those at the wrist joint proper. In this movement the navicular (scaphoid) shows a wide range of movement in relation to other bones of the proximal row.

Extension of the wrist is likewise compounded of radiocarpal and transverse intercarpal movements, but, in contrast to flexion, the greater range occurs at the radiocarpal. In addition, it is during this movement, as pointed out by MacConaill, that an elaborate screwing or locking mechanism comes into play which stabilizes the wrist.

In the total range of flexion-extension, it is surprising to find that slightly more than half of the movement occurs at the transverse intercarpal joint.

In adduction or ulnar deviation, the carpus moves as a whole about an axis in the region of the capitate (os magnum), the carpus closing up as it were, with the greatest displacement occurring at the radiocarpal joint. On the other hand, in abduction or radial deviation, a considerable amount of movement is intercarpal, the series of bones opening up like a fan in complicated adjustive movements.

At the common carpometacarpal and intermetacarpal joints, the range of movement is not great, but is none the less important with respect to the power of the grip. If the fingers are flexed *seriatim*, commencing with the index, it will be noted that each is carried successively to a common point over the ball of the thumb. This movement is functionally significant in not only permitting the fullest flexion of the fingers, but in opposing the frictional surface of the palm to the object grasped. It is brought about by slight rotation of the metacarpals on their long axes around the axis of the index finger, and is therefore greatest in the fifth metacarpal and least in the second. When a fist is made it will be noted by examining the metacarpus, end on, that the series form an arch. The importance of this arch in giving power to the grasp is familiar to every school boy who uses the manoeuvre of flattening out this arch to weaken the grip of his opponent on some fancied treasure. It is familiar too to the clinician, in the weakness of the so-called "flat" hand, which is so often a cause of disability after prolonged immobilization, or as a result of paralysis of the motor component of the movement, as in ulnar-nerve lesions.

From an analysis of these movements and their sites, it will be appreciated that a procedure which arthrodeses the wrist, but preserves the mechanism of the radio-ulnar and carpometacarpal joints, maintains as far as is possible the unity of action of the extremity as a whole. Such a procedure conserves the mechanism of power in the hand by leaving intact the possibility of adjustment at the radio-ulnar joints and motion at the carpometacarpal, and by substituting for the normal locking mechanism at the wrist one of permanency, and therefore losing only the movements of the radiocarpal and intercarpal joints.

DESCRIPTION OF THE OPERATION

The operation for arthrodesis of the wrist requires two incisions,—one over the crest of the ilium for removal of iliac bone, and one for exposure of the wrist joint. To expedite the procedure, it is best to remove the bone from the ilium as the first step, and then proceed with the operation for fusion of the wrist. In this way the transfer of instruments from one wound to the other is avoided. At times an assistant may remove the iliac bone while the surgeon exposes the wrist joint.

Exposure of the Ilium for the Removal of Grafts

The approach to the iliac crest, together with the type of graft which may be removed, has been described in a previous article. For removal

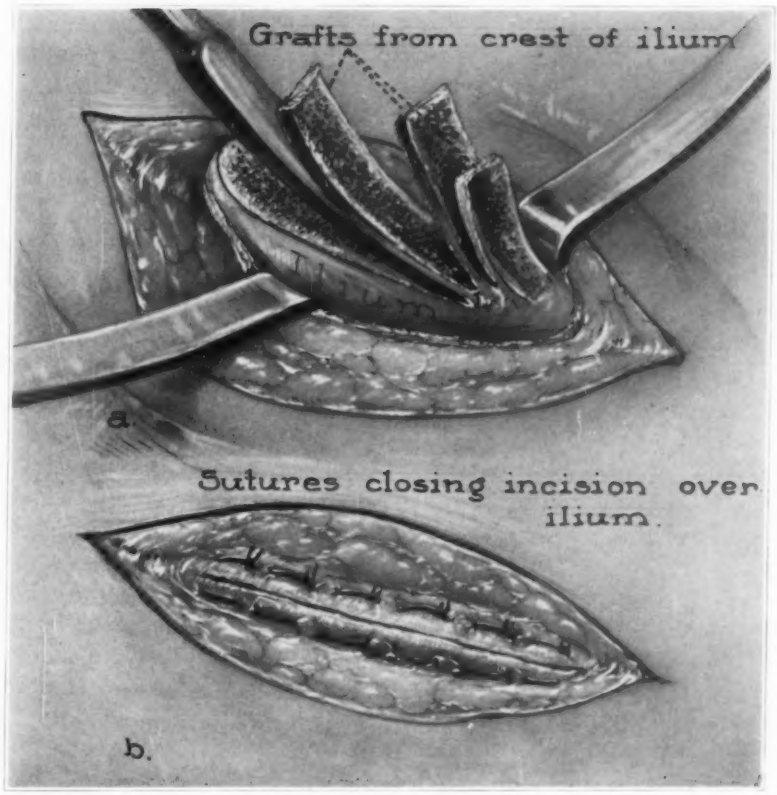

FIG. 1

The method of removal of grafts from the ilium with the osteotome held parallel to its crest.

of grafts for arthrodesis of the wrist, the anterior part of the ilium is exposed by an incision through the skin and subcutaneous tissue along the lateral margin of its crest. The junction of the external oblique muscle above, and the tensor fascia femoris and gluteus medius below, is recognizable as a white line where these muscles blend with the periosteum. Incision is made through the periosteum along this line. The periosteum is then elevated medially and laterally, care being taken to stay as close to the bone as possible in order to avoid bleeding. In children, the technique for exposure of the iliac crest is somewhat different, so as to disturb as little as possible the epiphyseal cartilage which rims the crest. The incision through the periosteum is made along the lateral border of the crest. The glutei are reflected laterally. The cartilaginous portion of the crest is incised along its junction with the bone, and is raised upward and medially. By this method the cartilage is not separated from the musculature of the trunk, and the major part of the blood supply is preserved. When the cartilage is completely elevated, the upper part of the medial surface of the ala or iliac fossa is exposed. The grafts are

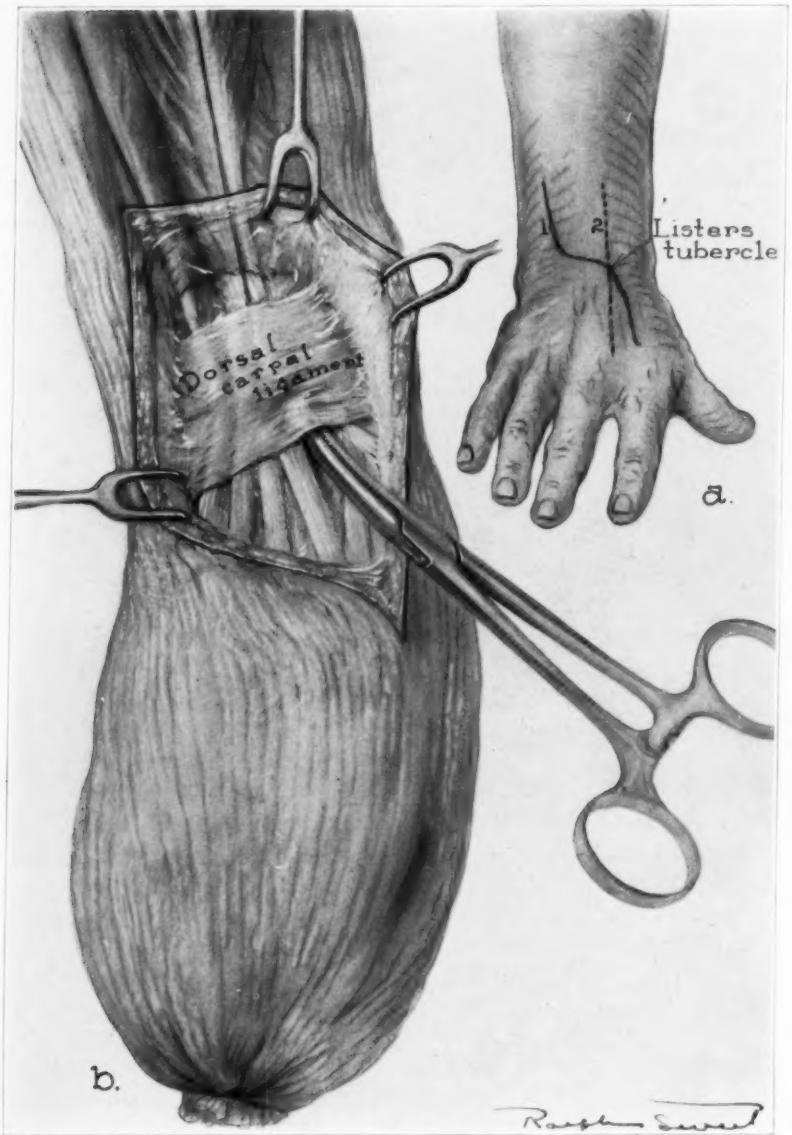

FIG. 2

a: Curvilinear and straight incisions with their centers over the dorsal tubercle of Lister.

b: Exposure of the dorsal carpal ligament which covers the sheaths of the common extensor tendons of the wrist and fingers. The point of the hemostat indicates the site of the incision through the ligament and periosteum on the lower end of the radius.

removed with an osteotome held either vertical to or parallel with the crest. In this way, grafts of various types can be obtained. For fusion of the wrist joint, grafts are removed with the osteotome held parallel to the crest (Fig. 1*a*).

The method of repair after the removal of the grafts is of great importance to the patient's postoperative comfort, and to an early resumption of activity. The periosteal attachments of the muscles of the trunk and thigh are firmly sutured together over the iliac crest, employing interrupted figure-of-eight sutures of No. 1 braided silk (Fig. 1*b*). In cases where small chip grafts have been removed, patients may walk without crutches in three weeks.

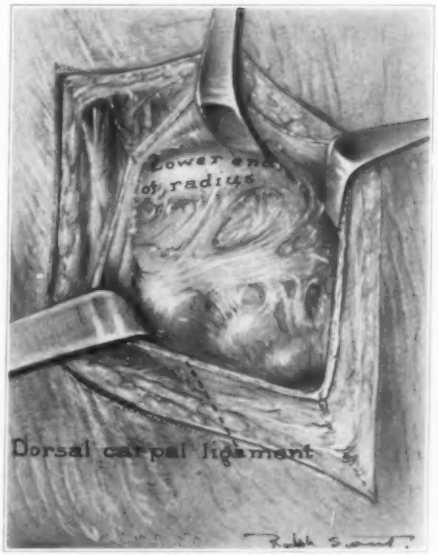

FIG. 3

The periosteum on the lower end of the radius has been reflected, and the radiocarpal and intercarpal ligaments are seen.

Exposure of the Wrist Joint

A blood-pressure cuff is used as a tourniquet. An incision which may be straight, or preferably curvilinear, is made over the posterior aspect of the wrist with its center over the dorsal tubercle of Lister (Fig. 2*a*). The latter is a bony projection on the dorsal surface of the lower end of the radius, which separates the extensores carpi radialis longus and brevis from the extensor digitorum communis. On retraction of the skin and subcutaneous tissue, the dorsal carpal ligament is exposed, and the several fibrous partitions which separate the tendon sheaths over the lower parts of the radius and ulna are clearly seen (Fig. 2*b*). This ligament, together with the periosteum, is incised vertically over Lister's tubercle. The posterior aspect of the lower end of the radius is exposed subperiosteally, care being taken to preserve as far as possible the tendon sheaths of the extensor pollicis longus, the extensores carpi radialis longus and brevis, and the extensor digitorum communis. These tendon sheaths are retracted to the radial and ulnar sides, in order to expose the dorsal aspect of the radiocarpal and intercarpal joints (Fig. 3). The posterior ligament of the radiocarpal joint is incised horizontally along the lower margin of the radius (Fig. 4). The wrist is then held in palmar flexion while the cartilage is removed with a special gouge from the lower end of the radius and the upper surfaces of the navicular and lunate (semilunar) bones. The intercarpal and the transverse intercarpal joints are exposed *en masse* by turning distally, with the aid of an osteotome, a curved flap, consisting of the fibrous capsule of these joints together with a thin section of cortex from the posterior surfaces of the navicular, lunate, and capitate bones.* In adults, a thin flap of bone from the dorsal aspect of the radius is then cut and turned upward with an osteotome (Fig. 5).

* The above method was described to the writers by J. Albert Key, M.D., of St. Louis.

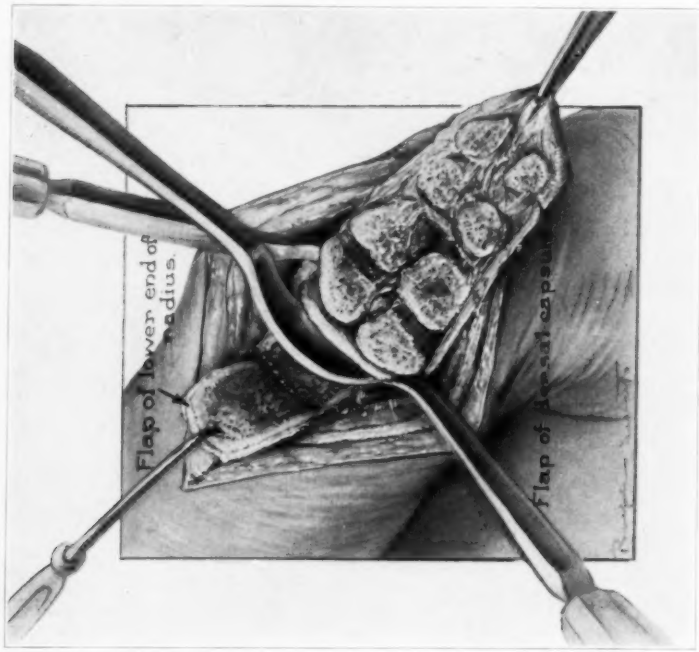

FIG. 5

The flaps are raised and the radiocarpal and intercarpal joints are exposed. The cartilage is removed from the radiocarpal joint with a curved gouge.

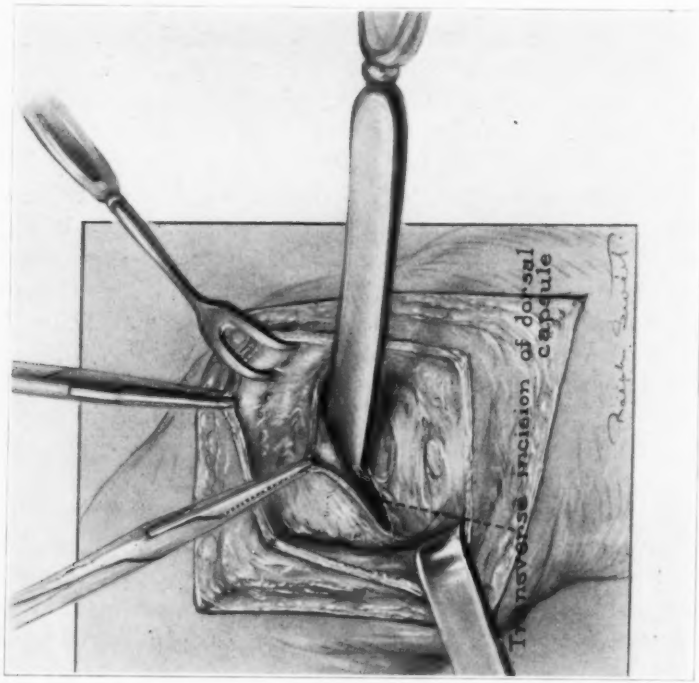

FIG. 4

The radiocarpal joint is opened through a transverse incision. The beginning of the osteotomy of the lower end of the radius and the dorsal flap is shown.

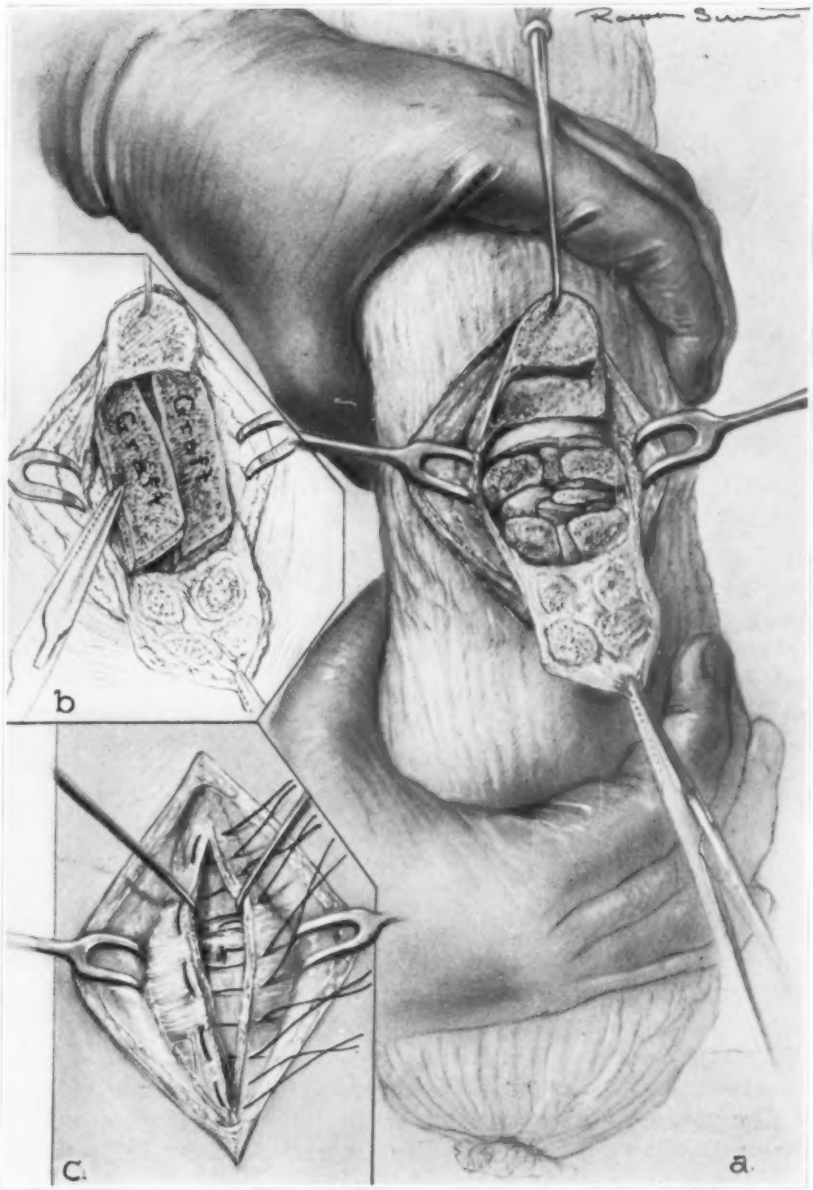

FIG. 6

a: Curved grafts are placed in the radiocarpal joint, and chip grafts are fitted into the intercarpal and transverse intercarpal joints.

b: Long grafts cover the lower end of the radius and the denuded carpal bones. The ends of the grafts are tucked beneath the bases of the radial and carpal bone flaps.

c: The margins of the flaps are approximated with mattress sutures lying deep in the transverse plane. Vertical mattress sutures close the dorsal carpal ligament.

In children, after a similar exposure of the joints, a horizontal cut is made on the articular surface of the lower end of the radius into which the grafts

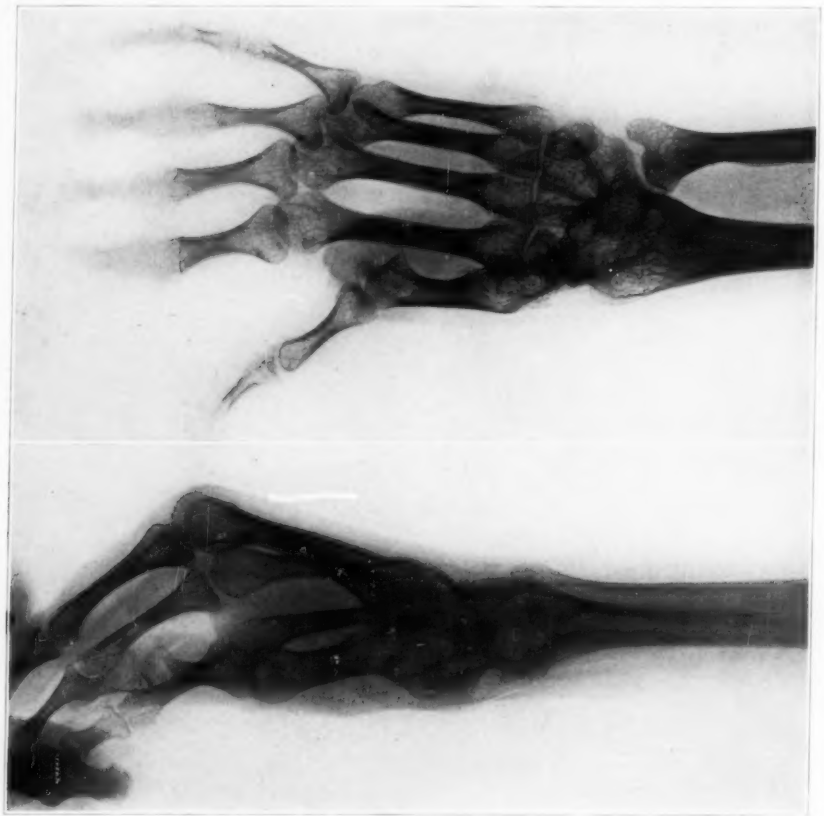

FIG. 7

Fusion of the wrist joint is solid. Note the trabeculation passing from the lower end of the radius to the carpus.

are eventually fitted, thus avoiding injury to the epiphyseal line. With a curette and sharp knife, the cartilage is removed from the inferior surfaces of the navicular, lunate, capitate, and, if readily accessible, the surface of the lesser multangular (trapezoid). The spaces between the denuded surfaces of the carpal bones and the lower end of the radius are packed with chips of cancellous bone derived from the ilium, and broad, pliable sections from the same source are then placed over the entire posterior aspect of the radiocarpal, intercarpal, and transverse intercarpal joints (Figs. 6*a* and *b*). Fixation of these grafts is secured by first tucking their upper and lower borders beneath the bases of the bone flaps which were raised from the posterior aspect of the carpus and radius, and later securing them by dorsal flexion of the wrist. The inferior radio-ulnar and the carpometacarpal joints are not exposed. The preservation of movement at the inferior radio-ulnar joint allows for normal rotation of the forearm, and for the pistonlike action of the radius on the ulna, which is essential for good function of the wrist and hand. As the carpometacarpal joints are left intact, the metacarpal arch of the hand is maintained, and the power and strength

of the grasp is preserved. Moreover, the few degrees of motion remaining in these joints allow sufficient movement to absorb the shocks encountered in the course of every-day activity (Fig. 7).

The wound is closed by silk sutures which approximate the margins of the bone flaps, the periosteum on the lower end of the radius, and the ligaments (Fig. 6*c*). A plaster-of-Paris cast is then applied, which extends from the upper arm to the tips of the fingers and the thumb, with the elbow held at a right angle and the forearm in the mid-prone position. The wrist is fixed in from 10 to 15 degrees of dorsal flexion, while the joints of the thumb and fingers are moderately flexed. The cast is carefully molded about the wrist and the palmar surfaces of the hand and fingers, and is cut over the back of the wrist and forearm to allow for swelling. At the end of three weeks, a second short plaster cast, extending from just below the elbow to the metacarpophalangeal joints, is applied. The position of the wrist is checked carefully at this time.

DISCUSSION

The relative merits of cancellous and cortical bone have been emphasized in a previous paper. In that publication it was stated that cancellous bone is more rapidly revascularized and revitalized by living bone than is cortical bone. It is plastic and can be molded to surfaces of varying contours. Consequently the application of grafts is less difficult than when cortical bone is employed. The writers have found cancellous bone to be especially adaptable in arthrodesis of the wrist. In addition, the risk of complications is greater when grafts are removed from the tibia. Fractures of this bone at the site of the removal of the graft are not infrequent, and may occur even after the lapse of six months.

In a series of forty-eight cases, for which complete histories and follow-ups are available, arthrodesis of the wrist was performed fifty times; sixteen for spastic paralysis, six for Volkmann's ischaemic paralysis, thirteen for the residual paralysis of acute anterior poliomyelitis, three for traumatic arthritis, three for obstetrical paralysis, four for injuries to peripheral nerves, three for tuberculosis of the wrist, and two in a case of bilateral congenital deformity of the forearm. It was not possible to record accurately the exact time of fusion in each case. However, in the more recent cases, the average time for firm fusion has been ten weeks, the earliest being eight weeks. This procedure is applicable to both adults and children. Although the youngest patient in this series was eight years of age, it is usually inadvisable to operate on children under the age of twelve years because of insufficient bone development. In only one patient, an adult, fusion did not occur over a period of two years. This case has been classified as a failure.

For paralytic conditions, both spastic and flaccid in character, with extensive involvement of the muscles of the forearm and hand, it should be emphasized that fusion of the wrist is the essential procedure for permanent improvement in function. Other operations, such as transplanta-

tion of tendons, should be regarded as purely supplementary. Therefore, arthrodesis of the wrist is of the same basic importance in reconstructive work for paralytic conditions of the upper extremity as stabilization of the foot in similar paralytic conditions of the lower extremity. In cases of spastic paralysis with palmar flexion of the wrist and fingers, a partial neurectomy of the median nerve has been employed as a preliminary procedure, and is of value because it relaxes the spasm of the flexor muscles and prevents the recurrence of deformity.

Stabilization of the wrist should be regarded as one of the most important reconstructive operations for permanent paralysis of the upper extremity, due to injury to the peripheral nerves. This is especially true in cases of complete paralysis of the muscles supplied by the radial nerve. If motion in the inferior radio-ulnar and carpometacarpal joints is not disturbed by the operation, the patient misses but little the motion of the radiocarpal and intercarpal joints. Loss of motion in these joints is more than compensated for by their stability. It is the experience of

FIG. 8-A

Case 4. L. B. Three weeks after operation there is fusion of the radiocarpal and transverse intercarpal joints.

the writers that in injuries to the radial nerve, the results of fusion of the wrist combined with transplantation of tendons have been far superior to the transplantation of tendons alone. Furthermore, this combination of fusion of the wrist with transplantation of tendons has been equally useful for the repair of the extensive muscle damage in Volkmann's ischaemic paralysis.

Arthrodesis of the wrist is indicated also in cases of arthritis of the wrist joint of both traumatic and infectious origin. Frequently it is the means by which a tuberculous wrist can be healed. When draining sinuses and secondary infection are present, an operation to obtain fusion at the wrist with the use of bone grafts is sometimes condemned because the grafts generally fail to unite and are extruded from the wound. In two instances of this type, however, fusion was secured by excision and the use of grafts of cancellous bone. In both cases healing of the sinuses and bony ankylosis were obtained.

The following cases are presented to illustrate each type of condition for which arthrodesis of the wrist has been performed.

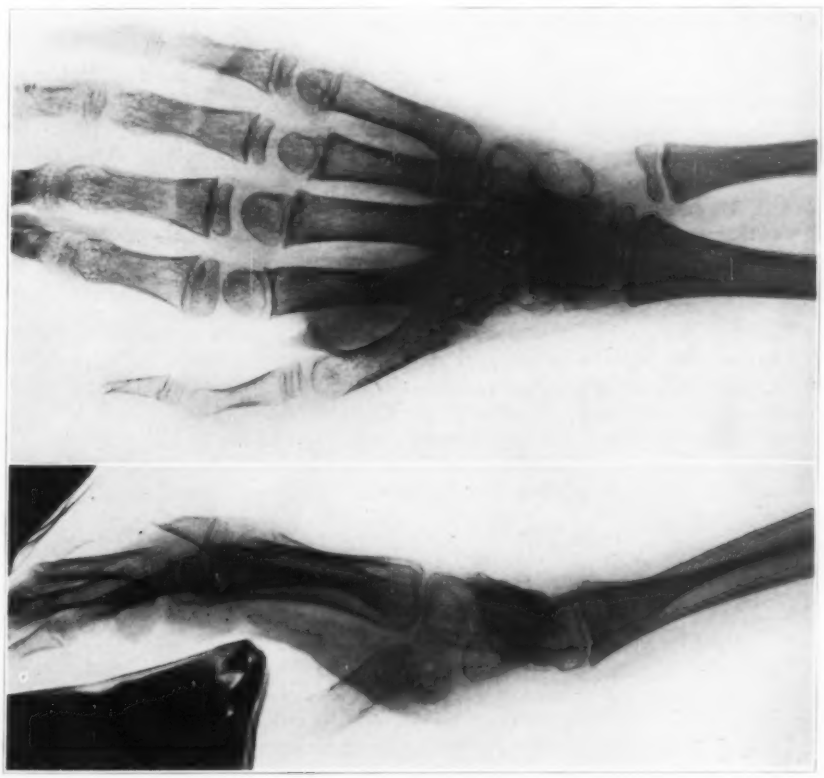

FIG. 8-B

Twelve weeks after operation there is firm fusion of the radiocarpal and transverse intercarpal joints, with preservation of motion in the inferior radio-ulnar and carpometacarpal joints.

CASE 1. A. H., eighteen years of age, entered the University of California Hospital on March 19, 1940.

The patient had sustained a supracondylar fracture of the left humerus at the age of fifteen years. One week after the injury an open reduction had been performed. The complications which followed the operation were a wrist-drop, infection, and subsequent osteomyelitis. Sequestrectomy had been carried out before he entered the University Hospital.

Examination revealed a united supracondylar fracture of the humerus, and a complete interruption of function of the radial nerve. The neurological surgeons were of the opinion that the injury and infection had caused a loss of substance of the nerve, and that an exploration would be of no benefit. Therefore, on March 22, 1940, the wrist was arthrodesed. Two months later a second operation was done consisting of transplantation of the extensor carpi ulnaris to the abductor pollicis longus, extensor pollicis brevis, and the extensor pollicis longus, transplantation of the palmaris longus to the extensor indicis proprius, and transplantation of the flexor carpi radialis to the common extensors of the third, fourth, and fifth fingers.

On May 21, two months after arthrodesis of the wrist, clinical examination and roentgenograms showed complete fusion. One month after the tendon transplantations, the patient had a strong wrist, with full flexion and extension of the fingers and a powerful grasp.

CASE 2. H. H., aged sixteen years, entered the Children's Hospital on July 6, 1939.

The diagnosis was spastic hemiplegia, a condition which had been present since the age of two months.

This patient had been hospitalized on a previous date, and a partial neurectomy of the popliteal nerve had been performed to correct an equinus deformity of the foot. At this time examination showed a flexion deformity of the wrist and fingers with marked spasticity of the flexor muscles. On July 11, 1939, a partial neurectomy of the median nerve resulted in considerable diminution of the spasm of these muscles. In October 1939, the nerve supply to the muscles of the thumb was partially divided, and following this, the thumb was in a better position, and there was less muscle spasm.

On December 4, 1939, an arthrodesis of the right wrist was done. Three months later there was solid fusion of the joint with marked functional improvement.

CASE 3. D. R., aged eighteen years, entered the Children's Hospital on July 1, 1940.

The diagnosis was Erb's palsy. The left wrist was held in palmar flexion, and there was very little function of the fingers. On July 11, 1940, an arthrodesis of the wrist and of the carpometacarpal joint of the left thumb was performed.

On September 5, 1940, roentgenograms showed bony fusion of these joints. Ten weeks later, there was firm fusion of both the wrist and thumb, with improvement in function of the extensors and flexors of the digits.

CASE 4. L. B., eleven years of age, entered the University of California Hospital on July 15, 1940.

The patient had had anterior poliomyelitis at the age of five years, the sequel of which was a residual paralysis of the right forearm. Conservative treatment had been carried out earlier with little improvement.

There was extensive paralysis of the muscles of the forearm and hand, the only good muscles being the extensores carpi radialis longus and brevis. However, there was some power of flexion in the flexor sublimis of the third and fourth fingers.

On July 18, 1940, arthrodesis of the left wrist was performed. Three weeks after the operation, fusion of the radiocarpal joint was beginning to take place (Fig. 8-A). In twelve weeks, there was complete fusion of the radiocarpal joint, and of the radial half of the intercarpal joints (Fig. 8-B).

On November 16, 1940, the tendons of the flexores sublimes of the index and of the fifth finger were joined to the third and fourth fingers respectively. In March 1941, the

extensor carpi radialis longus was transplanted to the extensor pollicis longus, and the extensor carpi radialis brevis was transplanted to the extensor digitorum communis. In August 1941, there was a very marked improvement in function.

CASE 5. A. M., aged eighteen years, entered the University of California Hospital on December 5, 1938.

The diagnosis was Volkmann's ischaemic contracture.

The patient had sustained a fracture of the left forearm near the elbow at the age of seven years. Following the fracture a Volkmann's ischaemic paralysis had developed. At the time of his admission to the Hospital, he showed the typical flexion contracture of the wrist and interphalangeal joints.

Early treatment consisted of a plaster cast which was wedged to correct the contractures of the tendons. It was impossible to obtain complete correction because of the bone deformity at the wrist. On December 7, 1938, this deformity was corrected by excision of the proximal row of carpal bones. These bones were sectioned for grafts. The distal row of carpals and the lower end of the radius were approximated, and this junction was covered with the grafts.

On April 27, 1939, the extensores carpi radialis longus and brevis were transplanted to the tendons of the flexor digitorum profundus.

In November 1939, the flexor carpi ulnaris was sutured to the extensor pollicis brevis on the anterior aspect of the wrist, a loop being formed by a part of the tendon of the flexor carpi ulnaris in the region of the pisiform bone.

On March 14, 1941, the wrist was solidly fused and the tendon transplants were functioning well.

CASE 6. P. P., aged sixty-five years, entered the Franklin Hospital on October 17, 1939.

For forty years the patient had had pain in the right wrist. His symptoms were not severe in character until 1936, when the wrist became swollen and extremely painful. In October 1936, the wrist had been excised by another surgeon, and a diagnosis of tuberculosis had been made. Since that time, there had been repeated flare-ups accompanied by pain and swelling, and ultimately by discharging sinuses.

Examination revealed a painful wrist with diffuse swelling of the soft-part structures, and several sinuses which discharged purulent material.

In October 1939, roentgenograms showed marked destruction of the lower ends of the radius and ulna, and of the proximal row of carpal bones. The disability was increasing, and the patient had little use of the hand.

On October 18, 1939, an arthrodesis of the wrist was performed. The lower ends of the radius and ulna were excised, and removal of the first row of carpal bones and partial resection of the distal row of carpal bones were carried out. Cancellous bone was transplanted from the ilium to promote fusion. The wounds were left open because of the infected sinuses. Convalescence was uneventful.

Eight months later roentgenograms showed bony union between the distal row of carpal bones and the lower ends of the radius and ulna. A slight discharge remained from a small sinus over the dorsal aspect of the lower end of the ulna.

On August 15, 1941, the wound was healed except for a small abrasion in the region of the lower end of the ulna. The wrist was rigid and painless.

CASE 7. J. K., thirty-five years of age, entered the San Francisco Hospital on April 15, 1935.

The patient had had influenza at the age of eighteen years, which was followed by pleurisy. Six months before he entered the Hospital he experienced pain on the distal aspect of the left radius. This area soon became swollen and inflamed.

Early treatment consisted of fixation in a plaster cast and the incision of abscesses. Acid-fast organisms were found in the pus.

On August 14, 1936, the carpus was partially excised and an arthrodesis of the wrist was performed. Six months later, the wrist was solid and painless.

CASE 8. J. A., twenty-seven years of age, entered the San Francisco Hospital on August 3, 1938.

A diagnosis of tuberculosis had been made in 1935, at which time an arthrodesis of the right ankle had been performed. Three months before he entered the Hospital, the patient had fallen and injured his left wrist. A few months after the injury, clinical and roentgenographic examinations showed evidence of tuberculosis of this joint.

On April 12, 1940, an arthrodesis of the left wrist was performed. Three and one-half months after the operation, the wrist was solidly ankylosed in good functional position.

SUMMARY

1. The writers wish to stress the importance of arthrodesis of the wrist for the improvement of function in disabilities arising from various paralytic conditions which affect the upper extremity. The operation has also been used successfully in the treatment of traumatic and infectious arthritis, particularly in cases of tuberculous origin.

2. This operative technique presents a method for securing rapid and certain fusion of the wrist with the use of grafts of cancellous bone from the ilium. Cancellous bone has advantages over compact bone.

3. An understanding of the surgical and functional anatomy of the wrist in performing arthrodesis of the wrist is important, because preservation of motion in the inferior radio-ulnar and carpometacarpal joints has functional value.

REFERENCES

ABBOTT, L. C., and GILL, G. G.: The Use of Cancellous Bone Grafts in Orthopaedic Surgery. Medico-Surgical Tributes to Harold Brunn. University of California Press, 1942.

DUBAR, L.: Greffes osseuses hétéroplastiques. Bull. Acad. de Méd., 3s. XXXVIII, 459, 1897.

ELY, L. W.: An Operation for Tuberculosis of the Wrist. J. Am. Med. Assn., LXXV, 1707, 1920.

LIEBOLT, F. L.: Surgical Fusion of the Wrist Joint. Surg. Gynec. Obstet., LXVI, 1008, 1938.

MACCONAILL, M. A.: The Mechanical Anatomy of the Carpus and Its Bearing on Some Surgical Problems. J. Anat., LXXV, 166, 1941.

SCHERB: Zur Versteifung des Hand- und Sprunggelenkes bei Lähmungen. Verhandl. der Deutschen Orthop. Gesellsch., 21st Kongress, 1926. (Beilageheft d. Ztschr. f. Orthop. Chir., XLVIII.) Stuttgart, Ferdinand Enke, 1927.

SMITH-PETERSEN, M. N.: A New Approach to the Wrist Joint. J. Bone and Joint Surg., XX, 122, Jan. 1940.

STEINDLER, ARTHUR: Problems of the Reconstruction of the Hand. Surg. Gynec. Obstet., XXVII, 317, 1918.

Orthopedic Operations on the Hand. J. Am. Med. Assn., LXXI, 1288, 1918.

Orthopedic Reconstruction Work on Hand and Forearm. New York Med. J., CVIII, 1117, 1918.

Operative Treatment of Paralytic Conditions of the Upper Extremity. J. Orthop. Surg., I, 608, Oct. 1919.

Operative Methods and End-Results of Disabilities of Shoulder and Arm. J. Orthop. Surg., III, 652, Dec. 1921.

Orthopedic Surgery of the Upper Extremity. Minnesota Med., VI, 431, 1923.

SPONDYLOLISTHESIS *

Report of Three Cases in Adults with Forward Displacement of the Vertebra below the Level of the Laminar Defect

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It has been the consensus that the essential factor or *sine qua non* in spondylolisthesis is a bilateral laminar defect separating the posterior arch from the body of the vertebra. Moreover, according to all records, the slipping always occurred in the vertebra with the laminar defect. The cases here reported seem unusual for several reasons:

1. The vertebra which became displaced was not the one with the laminar defect, but the one below it.

2. In one of the cases, the laminar defect was apparently unilateral, the subluxation occurring with the apophyseal joint of the uninjured side as the center of rotation.

3. In each instance, there was a trauma adequate to produce a fracture of the laminae; the symptoms appeared after the injury; and hence it seems possible that the slipping resulted from a laminar fracture,—that is, that the spondylolisthesis was of traumatic origin.

4. Although the patients were all adults, the slipping in each instance was only mild.

5. In two of the patients, the laminar defects appeared identical in location and extent, and there was a similar displacement and rotation of the posterior arches.

It remains for future experience to determine whether these findings necessarily indicate that the laminar defect is congenital, and militate against the suggestion that the spondylolisthesis is of traumatic origin.

CASE REPORTS

Case 1. J. K., a male, forty-four years old, was apparently well until November 11, 1938, when he lifted a cylinder of oxygen onto a truck. In this act he felt a very sharp pain in the right lower back, and was unable to straighten up. Several minutes later he was able to continue driving the truck. His discomfort continued, and, after several days, he consulted a physician who strapped his back and advised him to continue working. His pain increased, and he was provided with a low-back belt. He continued to work, wearing the belt, until February 1940 when one morning he found that he could not get out of bed because of intense backache. He has not worked since then.

Physical examination showed that the patient was muscular and well built, walked without a limp, and was able to undress and dress without assistance. His back was symmetrical. There were no undue prominences or depressions in any part of his back, and there was no break in the anteroposterior contour of the spine, such as is commonly seen in the typical spondylolisthesis. Flexion and extension of the spine were normal.

* Read before the Orthopaedic Section of the New York Academy of Medicine, February 20, 1942.

Lateral inclination to the left caused pain in both iliolumbar angles, while lateral inclination to the right caused pain in only the right iliolumbar angle. The side motions of his spine, however, were free. Jarring his head did not cause any pain in the back. Jumping down on his heels caused discomfort in the lumbosacral area and in both loins. There was marked tenderness to pressure over the lumbosacral region and to a less extent in both loins.

The lateral roentgenogram (Fig. 1-A) shows a forward displacement of the body of the third lumbar vertebra of at least one-quarter of an inch. There is a reduction in the intervertebral space between the second and third lumbar vertebrae, and sclerosis, and hyperostosis of the lower anterior portion of the body of the second lumbar. The articular facets of the second and third lumbar vertebrae appear to be closer than any of the other articular facets (this is seen more clearly in the original film than in the reproduction). The intervertebral foramen between the second and third lumbar vertebrae is smaller than any of the others. In an oblique view (Fig. 1-B) the laminar defect is clearly visualized. There is visible an irregular solution of continuity, possibly a fracture (seen perhaps more clearly in Figure 1-C), through the base of each inferior articular facet of the *second lumbar* vertebra,—that is, the posterior arch of the second lumbar is separated from the body with a wide gap between the fragments on the left side (*A*) and a narrower separation on the right side (*B*). The whole of the posterior arch appears displaced downward and to the right, and rotated on an anteroposterior axis, so that it is lower on the left than on the right side.

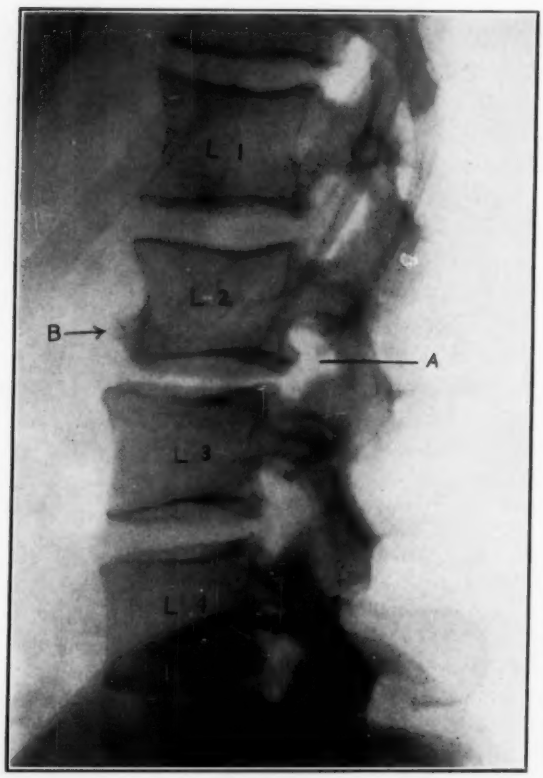

FIG. 1-A

Case 1. J. K. Lateral view of the lumbar spine. There is a forward displacement of the third lumbar vertebra. At *A* note the reduction of the intervertebral foramen between the second and third lumbar vertebrae. The intervertebral disc between the second and third lumbar is smaller than it should be. At *B* there is ossification of the anterior longitudinal ligament and spur formation.

This is an instance of spondylolisthesis of the third lumbar vertebra, although the laminar defect is in the second lumbar. In explanation of this rare and certainly unusual pathology, the authors are led to the hypothesis that the body of the second lumbar was so thoroughly bound to the first lumbar that the injury, which either caused the laminar defect by fracture or aggravated a previously existing congenital defect by stretching or tearing the fibrous

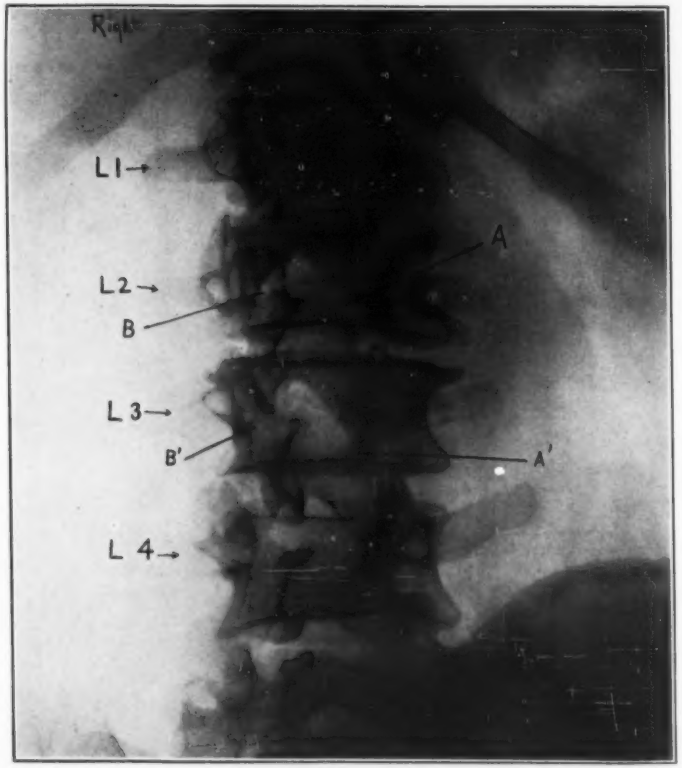

FIG. 1-B

Oblique view of the lumbar spine. At *A* and *B* are seen the fractures of the laminae at the bases of the inferior articular facets. The fractured posterior arch of the second lumbar vertebra appears displaced downward and rotated to the right. Note particularly that at *A'* and *B'*, the bases of the inferior articular facets of the third lumbar, there is no solution of bone continuity.

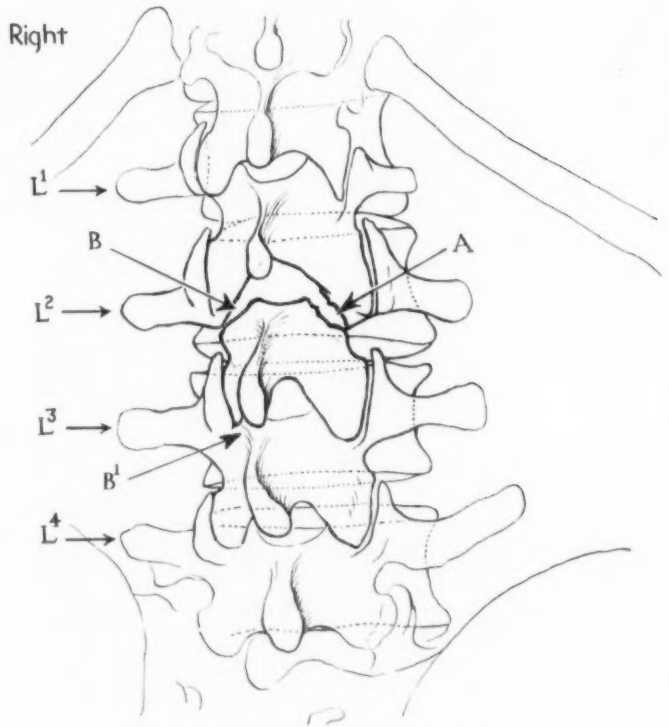

FIG. 1-C

Pen sketch of the previous roentgenogram to outline more clearly the laminar fracture and displacement of the posterior arch.

tissue bridging the laminar defect, precipitated the forward slipping of the third lumbar vertebra with the attached posterior arch of the second lumbar. One should certainly keep an open mind on the nature of the laminar defect in the second lumbar. Perhaps it was congenital but was not previously recognized in this patient. However, in view of the facts: (1) that this patient had not had any symptoms referable to his back prior to the injury; (2) that the symptoms came on directly after the injury and persisted; and (3) that fracture of vertebral processes can occur through severe muscle effort, it seems possible and likely that the defects in the laminae were actually fractures and that the spondylolisthesis was traumatic in origin.

CASE 2. A. I., a man of forty-nine years, was first seen on September 12, 1936, when he complained of backache of about two years' duration. In November 1934 he was in an automobile accident, the car in which he was riding being turned over. He did not recall any direct injury to his back, but he remembered that he did have pain in his back after the accident. He was able to leave the overturned car by crawling through a window. The sequence of events was not well remembered. He knew that his back was stiff and painful after the accident. About six months later a severe left sciatica developed of which he was relieved by injections.

At the time of the first examination, he had pain in the lower back radiating to the left hip. The pain was steady and dull, and was aggravated by rainy weather. He had noted no loss of sensation or strength in the lower extremities. The trunk was tilted to the right about 10 degrees. Flexion of the spine was free, and extension was almost normal. Left lateral bending was much limited, but right lateral bending was fairly free. The spinous processes of the third and fourth lumbar vertebrae were tender to pressure. There was no other point of tenderness in the back, and none over the course of either sciatic nerve. Straight-leg raising was normal on both sides. There were no sensory or motor disturbances, and the reflexes were normal.

The roentgenograms showed in the anteroposterior view (Fig. 2-A) a bilateral laminar defect, probably a fracture, of the second lumbar vertebra (*A* and *B*). The defect extended completely through each pedicle of the second lumbar vertebra, so that the posterior arch (*C*) was separated from the vertebral body, displaced downward, and rotated to the right, thus showing more of the right lamina than the left, while its spinous process was deviated to the left. The interval between the displaced laminae and the vertebral body was greater on the right than on the left side. The laminar surfaces, especially on the right side, were irregular. In addition, there was a linear defect or fracture through part of the right lamina of the third lumbar. The lateral view (Fig. 2-B) showed a mild forward slipping of the *third and the superimposed lumbar vertebrae* on the fourth lumbar.

This patient was hospitalized and treated by recumbency on a convex frame. In a short time his back became symmetrical, the spinal motions increased, the muscle spasm relaxed, and his pain was relieved. Thereafter his back was supported by a Knight spinal brace. He was last seen in December 1936, at which time new roentgenograms showed no union of the laminar fractures.

This patient exhibits a lesion of the posterior arch of the second lumbar vertebra identical with that seen in the previous case. The second lumbar vertebra did not become displaced as in the usual spondylolisthesis. Neither did the third lumbar and those below it slip forward as in Case 1. Instead the third lumbar and those above it were displaced forward on the fourth lumbar. The mechanism in the first case is clear. The third lumbar vertebra with the attached posterior arch of the second

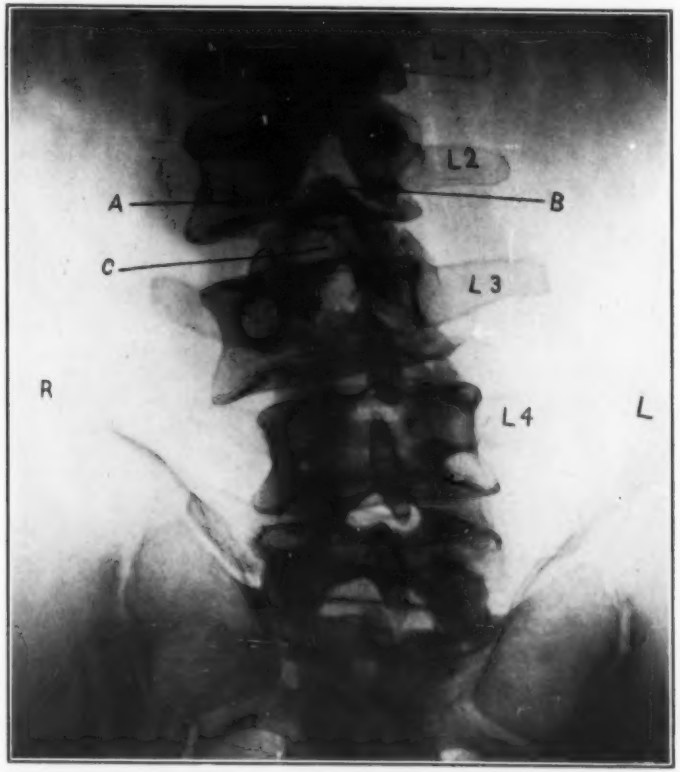

FIG. 2-A

Case 2. A. I. Note the bilateral fracture of the posterior arch of the second lumbar vertebra and the irregularity of the fractured surface of the right lamina. At *A* and *B* the separation of the posterior arch (*C*) from the body of the second lumbar is seen.

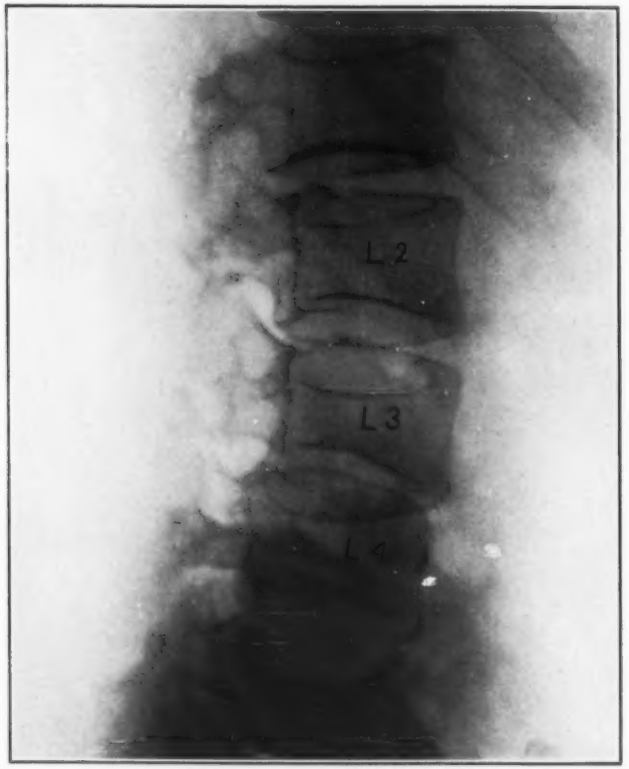

FIG. 2-B

Lateral view showing forward displacement of the third lumbar vertebra on the fourth.

lumbar now released from the body of the second lumbar, slipped forward carrying with it the securely attached vertebrae below it; but in this case the third lumbar and those above it slipped forward *en masse* on the fourth lumbar. This would seem explicable if the linear fracture of the right lamina of the third lumbar was more extensive than is discernible in the roentgenogram, and the rotation would indicate that it occurred about an intact left lamina as an axis.

In this case, as in the previous one, the authors are mindful of the fact that the laminar defect in the second lumbar may be congenital. However, because of the known injury, the irregularity of the laminar surfaces, and the linear defect in one lamina of the fourth lumbar, it would seem possible and very likely that the defect in the posterior arch of the second lumbar is the result of a fracture produced by the described injury.

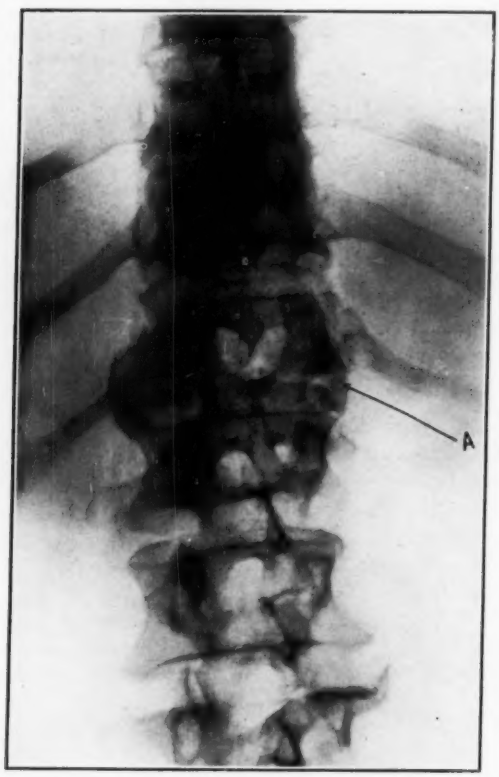

FIG. 3-A

Case 3. J. R. Anteroposterior view. Note the transverse fracture of the left lamina of the twelfth thoracic vertebra and the displacement and rotation of the first lumbar to the right.

CASE 3. J. R., a man of sixty years, was standing in a bus. The bus made a sudden turn with a violent jerk, so that the man was thrown to the floor. He struck the thoracolumbar region of his back against a step with a good deal of force. His back, he believes, was arched in hyperextension at the moment of injury. He complained of sharp pain at the site of injury, non-radiating in character. He became unable to bend or lift, and the pain was severe enough to keep him awake at night.

Examination on the day of the injury showed a short, slender, well-muscled man. He walked slowly, the trunk inclining to the right and forward. The lower thoracic and lumbar muscles were spastic. Flexion was possible to twelve inches from the floor. Lateral motions and rotation of the back were very much limited. There was less limitation of extension. The region of the first lumbar spinous process and the region of the lumbosacral joint were very tender to pressure. Straight-leg raising on the right side was restricted, because of pain in his back. Other leg tests gave pain in the back, and he voluntarily restricted the performance of these tests. Neurological examination was negative.

Roentgenograms disclosed in the anteroposterior view (Fig. 3-A) a linear defect, probably a fracture, of the left lamina of the twelfth thoracic vertebra. This defect ran

transversely, and extended into the left articular process (*A*). The first lumbar vertebra was luxated anteriorly (Fig. 3-B) and to the right. This luxation was associated with a rotation of the first and second lumbar vertebrae to the right. Advanced osteo-arthritic spurring was seen in the thoracic and lumbar vertebrae.

These roentgenographic findings were confirmed by stereoscopic examination of the thoracolumbar spine. It was noted that the fracture line of the left lamina of the twelfth thoracic vertebra extended to the base of the spinous process. The right apophyseal joint between the first and second lumbar vertebrae was widened.

A high plaster-of-Paris jacket was applied, which was replaced by a corset soon afterward. He is wearing this corset with relief. There is still limitation of motion and muscle spasm, and it is interesting to note that the greatest tenderness is located over the area of the lumbosacral joint.

FIG. 3-B

Lateral view showing forward displacement of the first lumbar vertebra.

It is believed that the luxation and rotation of the bodies of the first and other lumbar vertebrae are the result of the fracture of the left lamina of the twelfth thoracic vertebra, the first lumbar vertebra swinging upon the intact right lamina of the twelfth thoracic as if on a hinge. The widening of the right apophyseal joint between the first and second lumbar vertebrae is secondary to this movement.

DISCUSSION

These three cases of spondylolisthesis have one common finding,—namely, that after bilateral laminar damage in two cases and unilateral laminar injury in one, *the vertebra below the injured one* became subluxated anteriorly. In this regard these cases of spondylolisthesis differ from those commonly seen, and considered to be of congenital origin, in which the dislocation is of the vertebra with the laminar defect, and not of the one below it. Whether this feature is peculiar to a traumatic spondy-

lolisthesis the authors are not prepared to say. Conceivably and possibly the laminar defect in the first two cases was congenital, and the slipping was brought on by the trauma, severe in each case, which caused not only forward slipping, but a rotation of the vertebra.

In none of these cases was there consent for what would appear to be the treatment of choice,—namely, a spine fusion. Yet it would seem logical that, in the presence of such extensive injury and displacement, instability with recurrent or continuing symptoms is exceedingly likely, and hence an ankylosing or stabilizing operation is warranted and advisable.

SUMMARY AND CONCLUSION

These three cases of spondylolisthesis in adults were probably caused by laminar fractures. In two of the patients there were bilateral defects or fractures, and in one a unilateral defect. In the two cases with bilateral laminar defects, the posterior arches were displaced and rotated in identical ways. The vertebral displacement or slipping was unusual in that it occurred in the vertebra below that with the laminar lesion. The spinal motions in all of the patients were comparatively free.

The treatment of choice in these cases would seem to be a spine fusion to prevent chronic pain and disability.

FUSION OF THE METACARPALS OF THE THUMB AND INDEX FINGER TO MAINTAIN FUNCTIONAL POSITION OF THE THUMB*

BY CHARLES F. THOMPSON, M.D., INDIANAPOLIS, INDIANA

The use of autogenous bone graft to fuse the metacarpal of the thumb to that of the index finger, for restoration of opposition of the thumb, has proved itself sufficiently to justify its presentation as a useful means of rehabilitating the crippled hand. Foerster in 1931 reported the use of this type of bone graft in a paralytic hand. Allan of Birmingham reported the results in forty-three patients in whom he had restored opposition of the thumb to the fingers by this method of bone fusion.

Stabilization of the metacarpal of a thumb paralyzed by anterior poliomyelitis may be considered as a final step in surgical reconstruction of the hand. Such an operation should not hold precedence over transplantation of tendons. However, if muscle transplants have been unsuccessful, bony fixation of the metacarpal of the thumb may still improve grasping function of the thumb and fingers. This operation is also useful in maintaining the spastic thumb away from the palm; likewise it has proved itself to be of value in hands damaged by wounds in the forearm and wrist.

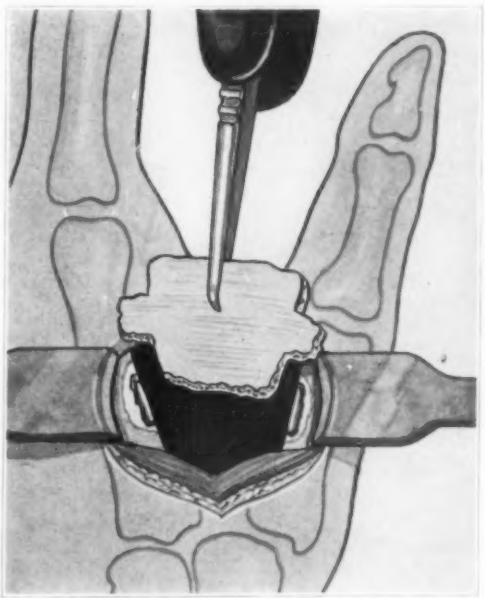

FIG. 1

Technique of insertion and fixation of bone graft between metacarpals.

The following points in the technique of this use of autogenous bone graft should be emphasized and adhered to to assure the most satisfactory results:

1. Exposure of the first interosseous space is obtained by dorsal longitudinal incision, and deep dissection must include isolation of the radial artery. The first dorsal interosseous muscle, whether atrophied or not, is carefully split, and preserved to cover the dorsal aspect of the graft. The adductor pollicis or its remnant forms the floor of the graft bed.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 14, 1942.

FIG. 2

End result of spastic paralysis in which fusion of the metacarpals fixed the thumb away from the palm.

2. Following subperiosteal exposure of the shafts of the metacarpals, the thumb is adducted to the limit of its mobility, and the adjacent surfaces of the metacarpals are marked by a small gouge. A drill is used to penetrate the volar cortex of the metacarpal of the index finger and the opposing cortex of the metacarpal of the thumb. This initial defect is lengthened to receive a spike on the bone insert. A minimal length of one centimeter is to be preferred.

3. The length of the cortical block from the anterolateral surface of the tibia must be gauged accurately by the distance between the bone recesses in the metacarpals, with the thumb held in extreme opposition. The corners of the cortical block are removed carefully by rongeurs and cutting forceps, leaving a keystone-shaped block with pegs for insertion.

FIG. 3-A

Roentgenograms of recent intermetacarpal graft, and end result of same graft after five years.

FIG. 3-B
End result.

4. The tension of tissues in the interosseous space is sufficient to hold the locked graft firmly. The mid third of the space offers an ample bed for such a graft without intruding on the radial artery.

5. The wrist and metacarpals are fixed in plaster for twelve weeks, so as to permit active use of the fingers and thumb for grasping, and this fixation is prolonged thereafter as is indicated. Four months has been the maximum period of fixation in this series. The metacarpal of the thumb may be held opposite the palm by counterpressure over the fifth metacarpal, in the plaster dressing. Plaster should support the space between the index finger and the thumb.

Hands of children under the age of fourteen have been considered immature, and therefore subject to growth defect if fused in this manner.

FIG. 4-A

Laceration of the forearm at the age of four, and secondary tendon and nerve repair at the age of eleven.

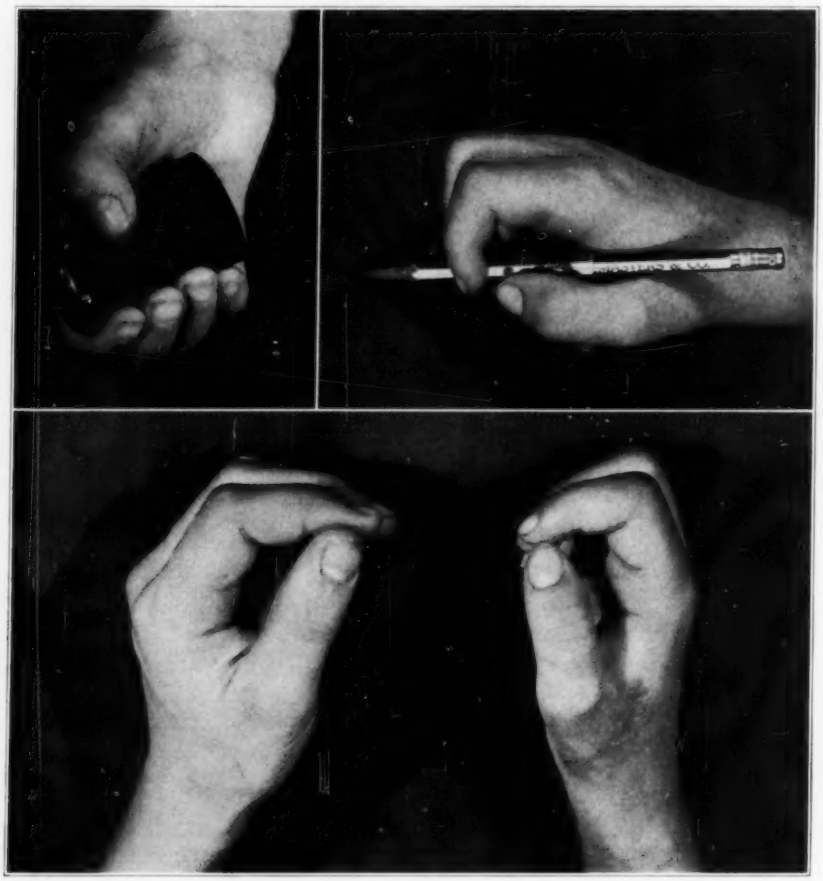

FIG. 4-B

End result.

In no instance has the metacarpal of the index finger rotated, allowing the thumb to resume its former displacement. In this series, there has been no trauma or fracture in the graft.

Observation of the healing of this type of bone graft, and subsequent restoration of grasping power between the thumb and fingers has reaffirmed the following principles of orthopaedic surgery:

1. A free bone graft and atrophied bone in which there has been retarded growth will undergo hypertrophy and accelerated growth in direct proportion to functional stress and stimulus.

2. Muscles of children and growing adults, which have been weakened by disuse for a period as long as twelve years, will regain power, if skeletal deformities are corrected and functional use is restored.

3. Fixed stability is preferable to unbalanced motion in certain types of impairment of rotation of the thumb.

This operation has been used in seven hands, the first of which was of a sixteen-year-old boy, who has remained under observation for a period of five years (Figs. 3-A and 3-B). The most recent case has been observed for nine months. Of these seven cases, one was a failure. A pseudarthrosis between the graft and the metacarpal of the thumb occurred. Fusion of the wrist for stabilization was done prior to fusion of the metacarpals. At the time of operation only slight flexion power in the index finger and thumb existed as a result of anterior poliomyelitis at the age of two years. In the other six cases, firm union between the graft and the metacarpals occurred. One of the latter was in the right hand of a girl of sixteen with a spastic hemiplegia in which motor-nerve section of the ulnar nerve at the wrist was followed by late contracture (Fig. 2). One of the good results was in the hand of a boy, fifteen years old, who at the age of four years sustained an extensive laceration of the right forearm which was complicated by infection (Figs. 4-A and 4-B). Both median and ulnar nerves were sectioned, and repair of the flexor tendons had been only partially successful.

This method of fusing the metacarpal of the opposed thumb to that of the index finger is to be recommended in carefully selected hands only. It remains as a final therapeutic measure where transplants are not available or have been inadequate in paralytic hands, and where thorough muscle reeducation and release or transfer of muscle tension has been inadequate in the hand affected by spastic paralysis; it utilizes the final remnant of grasping power between the thumb and finger or fingers in the traumatized hand, following adequate surgical repair of damaged tendons and nerves.

REFERENCES

ALLAN, F. G.: Personal communication.

FOERSTER, O.: Ersatz des Ausfalls der Muskeln des Daumenballens durch Fixierung des ersten Metacarpale in flectierter stellung mittels eines zwischen ersten und zweiten Metacarpalknochen eingefügten Knochenimplantates. p. 367. *In* Beitrag zum Werte fixierender orthopädischer Operationen bei Nervenkrankheiten. Acta Chir. Scandinavica, LXVII, 350, 1931.

CONTRIBUTORY CLINICAL OBSERVATIONS ON INFANTILE PARALYSIS AND THEIR THERAPEUTIC IMPLICATIONS*

BY A. STEINDLER, M.D., F.A.C.S., IOWA CITY, IOWA

From the State University of Iowa Hospitals, Iowa City

I. THE CONVENTIONAL PRINCIPLES

The challenge which confronts the conventional or, as it has been recently dubbed, the orthodox treatment of the acute and subacute stages of anterior poliomyelitis is directed principally against (1) uninterrupted immobilization, and (2) the exclusion of any and all mobilizing manoeuvres during that period.

In defense of the former principle, the old system contends that absolute rest does not cause atrophy of the muscles, that it is harmful to stimulate them in the early stage by muscle exercise, that the joints do not become rigid from immobilization, and that, on the other hand, the unopposed healthy muscle will lead to contracture unless the limb is continuously supported. In defense of the latter principle, it is claimed that motion is distinctly harmful to the paralyzed muscle; that it accentuates the paralytic state of a muscle to the point of total palsy because of easy exhaustion, and that the fatigability of the affected muscle is so great that many months are necessary to offset the bad effect of a single momentary indiscretion.

II. CLINICAL OBSERVATIONS

The question arises whether, in the face of this challenge, clinical and laboratory experiences actually warrant adherence to the old principle, or whether a change or a modification is justified.

A. *The Contractures.*

Are the paralytic contractures always due to the unopposed pull of non-paralyzed muscles, or do apparently paralyzed muscles contract?

From observations made in this Clinic within the last few years (by Sheplan, and others)† it has been found that contractures developed in patients who were splinted from the outset, as well as in untreated patients. These contractures were by no means always caused by the pull of the unopposed strong muscles. On the contrary, they were found frequently in muscles which were apparently severely paralyzed, particularly in the quadriceps and in the back muscles.

Two hundred cases from the Iowa epidemic of 1940 to 1941 were studied; most of them were admitted to the Hospital during the acute stage.†

* Read before the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 5, 1942.

† See Annual Report of The National Foundation for Infantile Paralysis, Inc., 1941.

Contractures of some kind developed in apparently paralyzed muscles in approximately 25 per cent. In cases of quadriceps paralysis which were immobilized by continuous splinting, extension paralysis of this muscle invariably developed, and more so in apparently severely paralyzed muscles. Subsequent mobilization of the contracted joint proved very difficult in spite of long-continued physiotherapy. These contractures developed as early as three and one-half weeks after the onset of the paralysis, and as late as eight months. The contractured quadriceps, though incapable of active contraction, is hard and indurated, and, when an attempt is made to flex the knee, there is pain and tenderness over the muscle belly and not over the knee, showing that the resistance is in the muscle and not in the periarticular structures. Apparently this is not a fixation contracture, as seen after plaster immobilization of normal

FIG. 1

Extension contracture of a completely paralyzed quadriceps.

muscles, because it develops so early under continuous splinting, and because it is so resistant to mobilization (Fig. 1).

True postural contractures may develop at the same time in nonparalyzed muscles. When the shoulder is placed in abduction for deltoid paralysis, there is a definite tendency to contracture of the trapezius, together with a contracture of the paralyzed deltoid, unless the splint is applied at considerably less than a right angle (Fig. 2).

In one-half of the patients, the trunk musculature was extensively involved. There was marked lordosis from paralysis of the abdominal muscles, but, when patients were placed in recumbency and traction, the lordosis promptly disappeared, and with it the abnormal tilt of the pelvis. Strangely enough, in this position an extension contracture of the lower back muscles frequently developed. This type of contracture was very resistant.

FIG. 2

Contracture of the trapezius with intercostal atrophy after the use of airplane splints.

B. *Ligamentous Relaxation.*

Ligamentous relaxation of the joint is observed independently of muscle involvement; some patients with paralysis of the deltoid show subluxation of the shoulder. A comparison with patients having peripheral paralysis of the axillary nerve shows the latter to have no such degree of disalignment.

It must be assumed that tendons, ligaments, and capsular rein-

FIG. 3

Ligamentous relaxation in poliomyelitis.

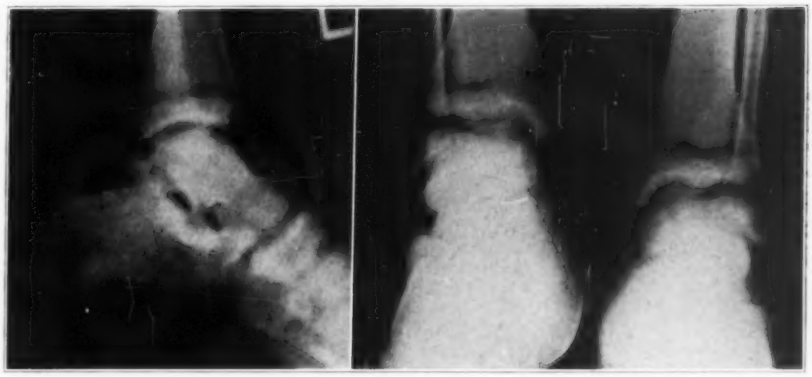

FIG. 4

Bands of supra-epiphyseal absorption, patchy sclerosis, and atrophy.

forcements are involved in pathological changes, as are the muscles (Fig. 3).

C. *Bone Atrophy.*

In the long bones of paralyzed extremities changes were observed consisting not merely in increased atrophic translucency and cortical thinning, but also in discrete transverse bands of absorption. That these bands were not disturbances of enchondral growth was evident in young adults with completely closed epiphyseal lines, where similar changes were found (Fig. 4). Also, it was found that the changes were most marked in patients with the more severe involvement of the surrounding musculature and in those who showed adjacent muscle contractures.

That lack of static function is not the determining factor in shortening was shown in a study of 160 cases. It appears that walking and weight-bearing played little, if any, part in the degree of ultimate shortening, as most of the shortening occured long after resumption of the static functions of the limb, but age at onset and degree of paralysis were much more potent factors.

D. *Sympathetic Changes.*

Observations at this Clinic (made by Dr. L. A. Russin)* seem to indicate that the poliomyelitic limb is hyperhidrotic (Fig. 5), hypothermic, and hyperpilomotoric. Until recently there has been no definite evidence that the lateral horns, which supply the preganglionic fibers of the sympathetic outflow, are involved in poliomyelitis. From experimental investigations, made by Dr. V. Wolkin of our Staff, with pilocarpine tests on novocainized and non-novocainized sympathetic nerves of poliomyelitic limbs, there is, in fact, reason to believe that the cause of hyperhidrosis is peripheral and not central; it is probably due to circulatory stasis caused by lack of muscle tone.† As the situation stands, the fact is simply accepted that serious circulatory disturbances exist in some of the severely

*See Annual Report of The National Foundation for Infantile Paralysis, Inc., 1940.
†See Annual Report of The National Foundation for Infantile Paralysis, Inc., 1942.

FIG. 5

Hyperhydrotic legs in poliomyelitis shown by the starch-iodine-sweating test.

paralyzed patients, in contrast to others equally severely paralyzed who show little or no damage to the circulation.

III. FACTORS CONTROLLING PARALYTIC SCOLIOSIS

The fundamental concept in regard to the production of scoliosis is based on the premise that the spine normally is endowed with a powerful protective apparatus, essentially of a passive nature, which guards the spine against scoliotic deformation. This consists of the stabilizing effect of the thoracic cage through the vertebral anchorage of the ribs; of the orientation of the intervertebral articulations; of the physiological anteroposterior curves which lock the spine against both lateral deviation and rotation; and, finally, of the intrinsic elasticity of the ligamentous structures of the spine, the longitudinal ligaments, and the discs. This immense store of intrinsic tension and pressure stresses makes the spine into a rigid rod, even without the supporting action of the muscles. This is mentioned specifically to point out that paralytic scoliosis is not merely a case of simple muscle imbalance.

The following clinical observations on the development and course of paralytic scoliosis were made principally by Dr. Farkas of our Staff.

In the majority of cases it requires from four to five years for full development. This means there is a phase of "unsettled" deformity, which is most valuable for prophylactic measures.

The direct muscle imbalance (the pull of a healthy muscle against a paralyzed opponent) seems inadequate to explain the scoliosis. A definite pathological condition, aside from muscle involvement, must be assumed,—a condition which interferes with or destroys the passive intrinsic equilibrium. Muscle imbalance cannot explain the translatory shift,—because this presumes some "give" of the ligamentous structures as well as of the intervertebral discs (Fig. 6).

A. *The Rôle of Pelvic and Thoracic Rotation in Producing Paralytic Scoliosis.*

It has been observed that the longitudinal rotation which always precedes lateral deviation is characteristic of the paralytic scoliosis.

1. *Pelvic Rotation.* The pelvis is the most potent factor in spinal rotation; though the rotation is counteracted principally by the system of intervertebral discs. Contracture of the hip, uneven position in bed, asymmetry of gait, equinus, *et cetera*, can bring about an asymmetrical rotary effect of the pelvis, and is therefore of great prognostic importance. This pelvic rotation is transmitted into the entire lumbar and lower thoracic spine in the same direction, and results, in the great majority of cases, in a final long thoracolumbar or total curve. It has been observed (by Dr. Farkas) that for a long period the lateral curves following rotation are concave rotation curves, but this is a temporary stage; the final curve is always convexly rotated.

2. *Thoracic Rotation.* Thoracic rotation is another essential factor.

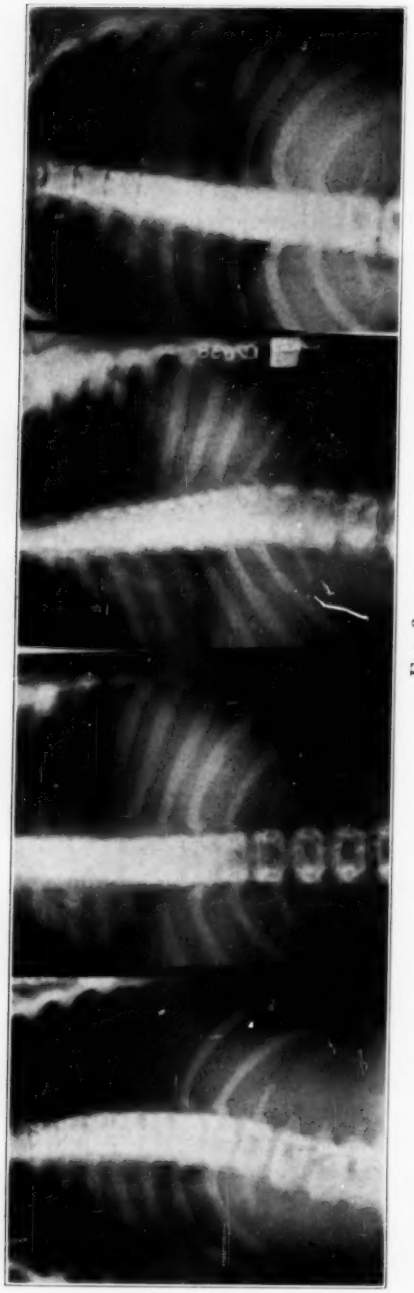

Fig. 6

B. D. Translatory shift, showing concave rotation.

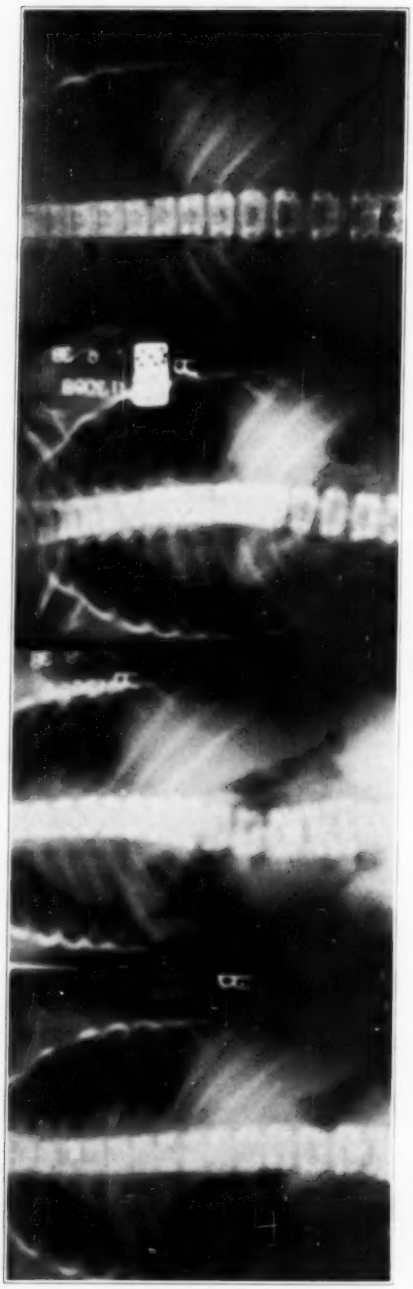

Fig. 7

H. W. Change of side of convexity. Spontaneous healing.

If the physiological effect of respiration upon the spine is affected, low vital capacity is the result, and the diaphragm stands high. The intervertebral disc, together with other ligamentous structures, maintains the integrity of the thoracic spine, and with it the respiratory function. Failing in this, a disalignment between the thorax and spine occurs as the natural safeguards break down,—hence the translatory penetration of the spine into the thorax, and the development of a lateral curve. It follows that preservation of respiratory function from the start is essential.

In this connection respiratory rigidity or spasm may be mentioned. Twelve patients had definite respiratory paralysis, necessitating the use of a respirator. Contracture (or spasm) of the paralyzed intercostals was noted in several cases, and considerable effort by the physiotherapist was necessary to restore normal ability of the ribs to flare outward and to expand in normal inspiratory excursion. Later, breathing exercises were of great value.

The "breakdown" of the spine, outside of muscle imbalance, may thus be due to the relaxation and instability of the skeletoligamentous system, as evidenced by the bone atrophy extending all over the spine; by the early ossification of ring epiphyses, even at the age of four (normally this occurs in girls at eleven, and in boys at thirteen); by the narrowing of intervertebral discs (Schmorl's pearls); by their greater compressibility; and by calcium deposits.

All these make possible translatory shifts of the vertebrae, the unilateral disc compression, and the early vertebral rotation; and all these changes are reversible in their early stages (Fig. 7).

The increased anteroposterior flexibility of the spine and the increased lordosis may also disappear with the recovery of the ligament-disc apparatus, except when abdominal muscles are involved.

B. The Rôle of Muscle Involvement in Producing Paralytic Scoliosis.

On the other hand, without muscle involvement, paralytic curves do not develop, even though additional involvement of the ligament-disc apparatus is present.

It is not possible to establish a correlation between involvement of individual back muscles and scoliosis, but it can be said that:

1. No case of pelvic rotation was seen without asymmetric involvement of the lower extremities.

2. In most cases of thoracic rotation, there was involvement of shoulder muscles or serious disturbance of respiration.

3. Two types of contractures leading to scoliosis were seen,—contracture of the lateral abdominal muscles and of the sacrospinalis, with pelvic obliquity and lumbar curve; and contracture of the respiratory type with rotation of the thorax and thoracic curve.

The immediate cause of rotation is then the pathological muscle imbalance between the two sides of the body; the more remote cause is the decreased resistance against rotation from damage to discs and ligaments.

IV. THERAPEUTIC IMPLICATIONS

The therapeutic implications of these findings for the acute and subacute stages of infantile paralysis can now be stated briefly.

As has been pointed out, the motor loss from involvement of the anterior-horn cell is the principal, but by no means the only, pathological feature of infantile paralysis, and the treatment plan is necessarily influenced by the additional clinical factors of pain, muscle spasm, and contractures due to spasms, and substitutionary and mass movements.

Pain, spasm, and spasmodic contractures arise from proprioreceptive stimuli. For the first two the author has fully accepted Miss Kenny's splendid technique of hot packs, and for the latter, he favors early motion. Splints or sand bags are used where they offer protection against pain or serve to prevent fatigue,—that is, intermittently. The factor of muscle spasm was observed to be an impediment to the return of muscle function. In those cases in which the muscle spasm and contractures could be easily overcome, the gain in muscle power was more easily accomplished. For the treatment of substitutionary or mass movements, Miss Kenny's excellent technique of individual muscle training and selective muscle exercises has also been adopted (Fig. 8). These succeeded particularly in reestablishing the function of the deltoid and tibialis anterior. In one of the cases treated by hot packs and muscle reeducation only, the tibialis anterior, which had started at zero, improved to a classification of good. The remainder of the muscles which showed improvement started out as fair or better and progressed to good. In other cases it was observed

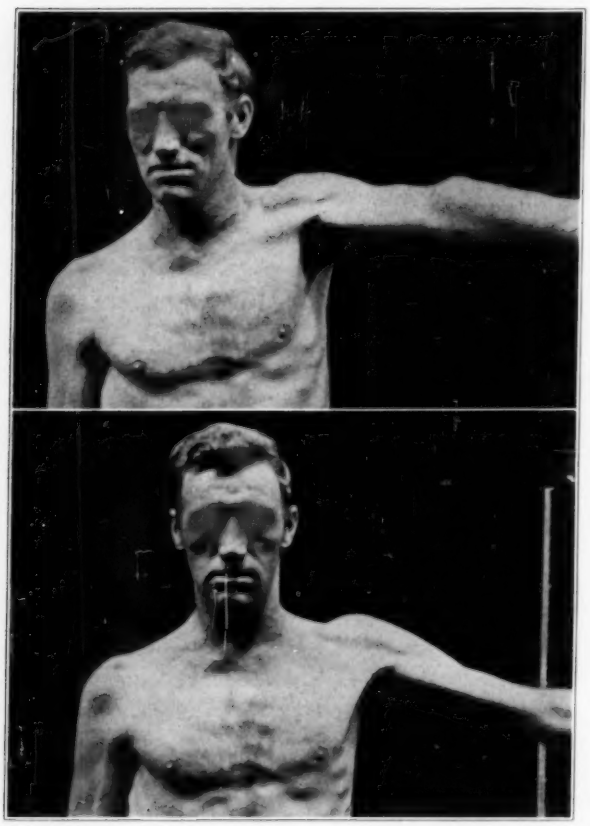

FIG. 8

Mass movements (substitution), reeducated with hot packs and training.

that, although no definite muscle improvement could be noted in any particular muscle, the function of an extremity, and in some cases the gait, was definitely improved because of the elimination of incoordination and mass movements (substitutionary movements) by muscle reeducation. The author is, however, going to continue the use of braces in ambulatory patients where the static functions of standing or walking demand it, and especially since it is necessary to protect the relaxed periarticular structures of the knee and ankle.

In the specific situation of paralytic scoliosis, there is a rather long period between the onset and the final settlement of the scoliotic curve, and there is ample opportunity for prophylaxis and early treatment.

First of all, recumbency is imposed on the patient for a matter of several months wherever there is reason to believe that a paralytic scoliotic curve is developing. To this is added a regimen of high-vitamin diet and physiotherapy. Respiratory capacity is tested by proper measurement, and is improved by respiratory exercises. The pelvis is derotated in recumbency by proper positioning of the patient. The position of the diaphragm and the flare of the ribs, as well as the outlines of the intervertebral discs, are noted in the roentgenogram as they improve under treatment. The pelvic thoracolumbar curves can be seen to improve as the rotation is controlled.

After the age of sixteen, the prognosis of paralytic scoliosis is favorable, except for the cases in which the patients are kept in a constant sitting position.

Patients are encouraged to start walking on crutches or by help of a tripod for nearly all the time they are out of bed. Sitting is prevented as much as possible. After the period of recumbency, the general and local treatment is continued as before, and the trunk is held by a support.

It should be understood that the author is referring to the paralytic scoliosis in the stage of development only; this entire plan of treatment reaches its limit the moment the curves are "fixed". Then the ligamentous structures and discs are "set", and the changes are no longer reversible. From here on the principle of restoring posture by compensation methods is still held; and only in case the latter fails to produce permanent compensation and restoration of posture are operative procedures indicated.

Likewise, it should be understood that the practice of physiotherapy and muscle education refers only to the treatment of the acute and subacute stages of infantile paralysis in general. Improvement in both muscle strength and selective action has been noticed up to two years after the onset of paralysis. Weaker muscles may gain strength after that time, but no "zero" muscle was noted to recover after more than two years.

The permanent deformities and disabilities which are found in the chronic stage, of both the extremities and the trunk, are in no way affected by these changes in the conventional treatment, except in so far as their frequency and the degree of ultimate deformities are influenced by it.

A SPLINT FOR FRACTURE OF THE CARPAL NAVICULAR

BY ERIC L. FARQUHARSON, M.D., F.R.C.S. (ED.), EDINBURGH, SCOTLAND

In fracture of the carpal navicular (scaphoid), treatment is long, but the life of a plaster cast is short. As the period of immobilization may extend into several months, the patient is often compelled, by economic or other necessity, to return to light work during treatment—indeed he is rightly encouraged to do so. The effective life of the plaster cast, however, is inversely proportional to the strains placed upon it. The part of the cast covering the forearm and hand may remain firm, but any plaster in the palm is liable to become softened or cracked by contact with objects held in the hand, and, if even light manual work is to be carried out, its destruction is only a matter of time. Furthermore, it is impossible to keep the palmar portion of the cast completely dry. When the fingers are being washed, a certain amount of splashing is inevitable, and sweating of the palm has a similar deleterious effect. Even in the case of fractures which heal in the minimum time of six to eight weeks, it is usual for two casts to be required. In fractures requiring immobilization for several months, a succession of plaster casts must be applied.

It is the opinion of Watson-Jones that "every single movement of the wrist joint puts back the process of repair by several days. It is the neglected plaster which causes delayed union and non-union". However, the term "neglected" may be applied to many of the casts which are replaced. The patient is, of course, instructed to report back to the surgeon without delay, if the cast becomes loose or broken; but it is difficult to make him understand the degree of fixation required; and he is usually content to believe that the cast is satisfactory as long as the greater part of it is firm. Furthermore, if he lives at some little distance from a hospital, it may be difficult for him to have his cast renewed as soon as he suspects that it is becoming soft. All too frequently, therefore, he returns wearing a plaster, which, for several days or longer, has been giving inadequate support. Moreover, it is rare for the surgeon to renew a cast which still appears to be firm and tight-fitting; he usually waits until there is some sign of softening. By this time, a little movement is taking place at the wrist joint, and again the cast must be described as "neglected". During the removal of a cast, further movement at the wrist joint is inevitable, with consequent retrogression in the healing process.

It is to avoid such interruptions in the continuity of immobilization that a special splint has been devised. This consists of a framework to which is attached an adjustable band for encircling the hand. The framework, which is made of light metal, is applied to the dorsum of the forearm and hand. It is incorporated in a plaster cast which extends only as far as the level of the wrist joint. The encircling band is made of soft aluminum, and is easily molded around the hand by digital pressure. It is adjustable by means of a bolt, which can be turned with a small coin.

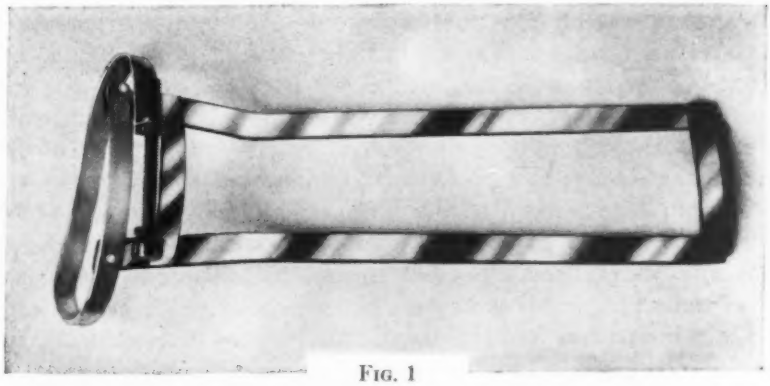

FIG. 1

Special splint for the treatment of fracture of the carpal navicular. *(Reproduced by courtesy of E. & S. Livingstone.)*

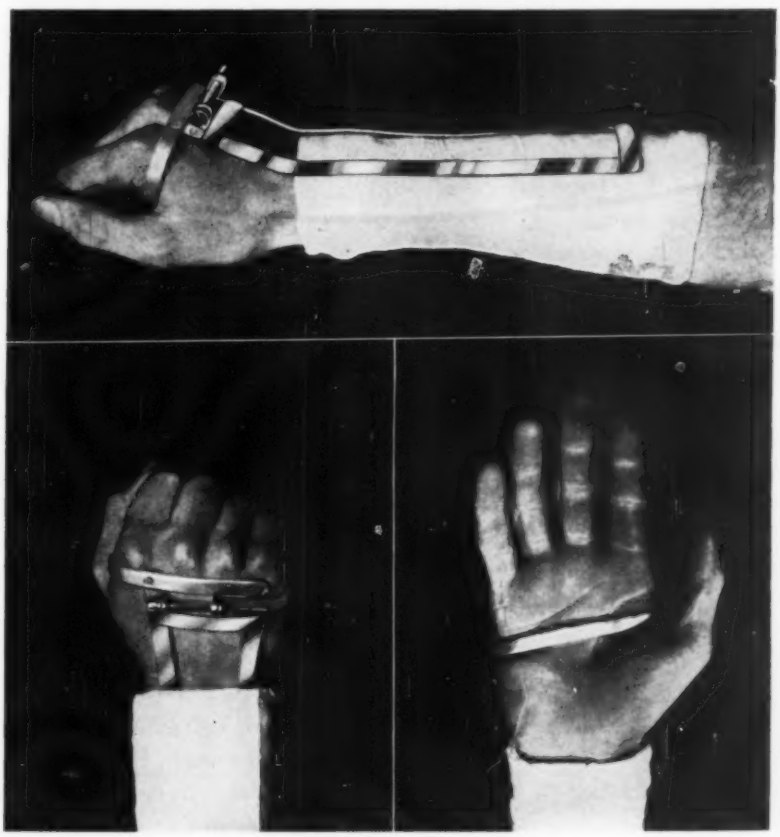

FIG. 2

Application of splint. The framework of the splint is shaped to fit the plaster cast so that it lies comfortably and evenly against the back of the hand in the required position of dorsiflexion. It is then incorporated in the cast. The aluminium band lies proximal to the palmar creases, so that movements of the fingers are unrestricted. *(Reproduced by courtesy of E. & S. Livingstone.)*

The standard splint, as supplied by the manufacturers, is designed so that the circumference of the band may be varied between eight and nine and one-quarter inches,—that is, it will fit the hand of most adult male patients. Other sizes must be especially ordered. The framework is shaped to hold the hand in moderate dorsiflexion, but, being of soft metal, it can be bent easily with a spanner to suit individual requirements.

The splint, together with the method of application, is shown in Figures 1 and 2. A light plaster cast, composed of one four-inch bandage and extending down to the level of the wrist joint, is first applied. The framework of the splint is bent so that it lies *comfortably and evenly* against the skin of the back of the hand in the required position of dorsiflexion, and it should also be shaped so that it lies closely against the surface of the plaster cast (Fig. 2). It is then incorporated in the cast with a second plaster bandage. Finally, the aluminium band is molded by digital compression to the contours of the hand, and is tightened by means of the bolt. If careful attention is paid to the molding of the splint, and if the patient's cooperation in indicating areas of pressure is secured, absolute fixation of the wrist joint can be obtained without any discomfort to the patient. The band lies proximal to the transverse creases of the palm, so that flexion of the fingers is unrestricted. The patient is instructed that the band should be kept as tight as can be comfortably borne. The circumference of the hand may vary considerably with the temperature of the surroundings, and adjustments should be made accordingly.

The splint provides no immobilization of the first metacarpal bone, but whether or not this is absolutely necessary is open to question. Movements of the first metacarpal may reduce to a slight extent the degree of immobilization at the site of fracture, but there is little evidence to suggest that this is a factor of any great importance in the healing process. The main cause of delayed union is to be found in the shearing strains to which the fracture is subjected by even slight movements at the wrist joint. The splint immobilizes this joint most effectively, and, in the cases where it has been employed, progressive union has taken place.

The splint lasts indefinitely, and the plaster cast which secures it to the forearm should not require renewal for several months. If the patient will cooperate in adjusting the aluminium band to suit the variations in size of the hand caused by temperature changes, more complete immobilization can be obtained. When carefully applied, the splint is no more uncomfortable than a plaster cast; it interferes less with active use of the hand, and the fact that the plaster does not extend below the wrist allows the hand to be washed as usual. The framework of the splint does not interfere with roentgenographic examination of the fracture.

The author has also used this splint with success in a recent case of delayed union of a fractured carpal navicular in which a bone-grafting operation was necessary. By means of this splint, the patient was able to return to his normal duties three and one-half weeks after operation, and union was firm five months later.

CONGENITAL UNILATERAL ABSENCE OF THE PECTORAL MUSCLES OFTEN ASSOCIATED WITH SYNDACTYLISM

BY EBER RESNICK, M.D., LOS ANGELES, CALIFORNIA

From the Children's Hospital, Los Angeles *

The most frequently encountered muscle anomaly in humans is a unilateral congenital absence of the pectoral muscles. In 1902, Bing [1] reviewed the literature completely, and found that absence of the pectoral muscles occurred approximately six times more frequently than any other anomaly of the muscle system.

There have been numerous reports of associated deformities in patients with an absence of the pectoral muscles. The only deformity found in the present short series was a congenital syndactylism of the fingers, varying in degree, and present on the same side of the body as the muscle anomaly. The three patients who presented syndactylism showed a shortened forearm as well as shortened fingers,—probably as a result of a disuse atrophy.

Mention has frequently been made of a degenerative lesion of the central nervous system—usually an aplasia of the brain—which is frequently associated with syndactylism, but the four patients reported were perfectly normal mentally.

Roentgenograms of the chest were made in all cases, and no bone deformity was reported.

CASE 1. (See Figures 1-A and 1-B.) M. C., aged three years, showed a deformity of the right chest, which had been noticed since birth. The mother had been told that it was due to a birth injury.

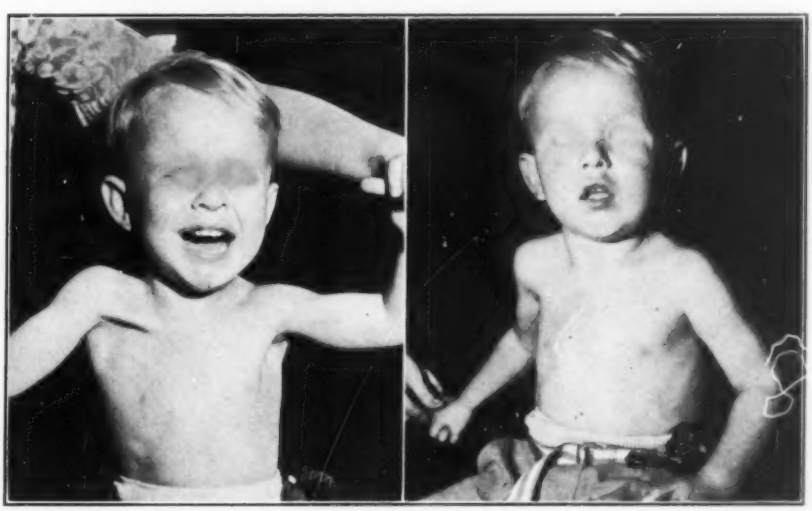

FIG. 1-A FIG. 1-B

* Orthopaedic Service of John C. Wilson, M.D.

Physical examination revealed a markedly flattened right chest. Motions of the shoulder were normal but on flexion of the right humerus with slight external rotation, a thin band of tissue, apparently the fibrosed remnant of the clavicular head of the pectoralis major, stood out very prominently. The asymmetry of the chest was quite marked. There was no evidence of syndactylism. The forearm and finger lengths were equal.

Case 2. (See Figures 2-A and 2-B.) R. B., three and one-half years old, was brought to the Hospital for a deformity of the left chest with webbing of the fingers.

Fig. 2-A

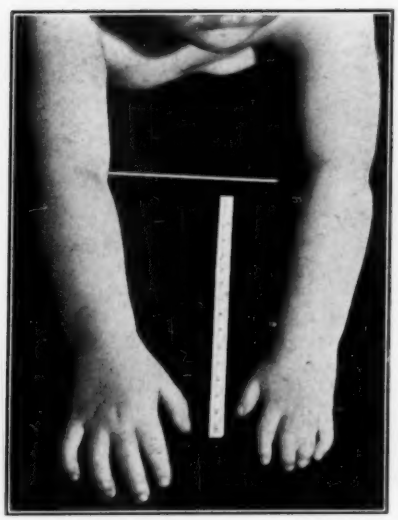

Fig. 2-B

Fig. 3-A

Physical examination revealed asymmetry of the chest with loss of subcutaneous tissue over the left breast region, and a somewhat depressed thoracic cage on the left. The pectoralis major and pectoralis minor were absent on the left. There was webbing

FIG. 3-B

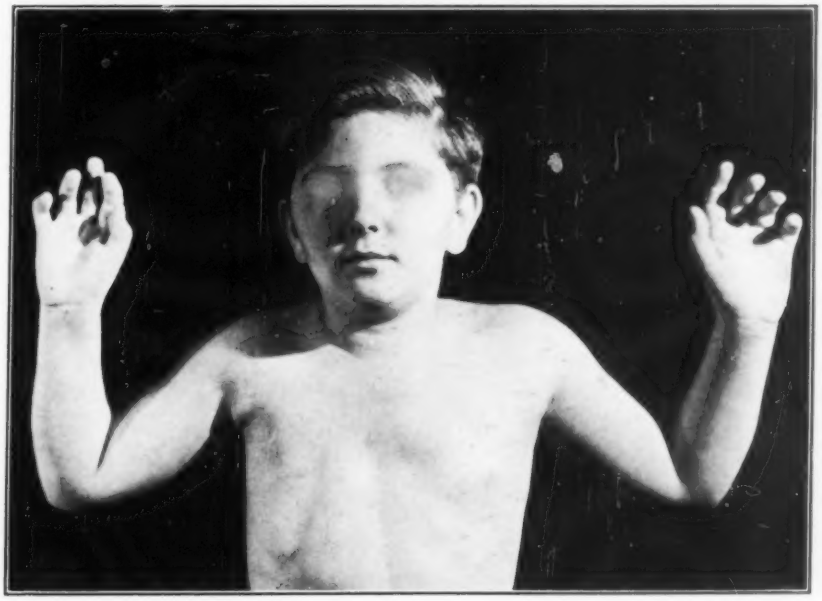

FIG. 4-A

of the index and middle fingers to the proximal interphalangeal joint, and of the middle and ring fingers to the distal phalangeal joint. The left forearm was two and five-tenths centimeters shorter than the right, and the left hand and fingers were smaller.

CASE 3. (See Figures 3-A and 3-B.) T. S., aged three years, had a flattening of the right chest with webbing of the fingers of the right hand.

Physical examination revealed an absence of the pectoral muscles on the right. The right forearm was three centimeters shorter than the left, and the right hand was smaller. A webbing was present between the index and middle fingers of the right hand extending to the distal phalangeal joint.

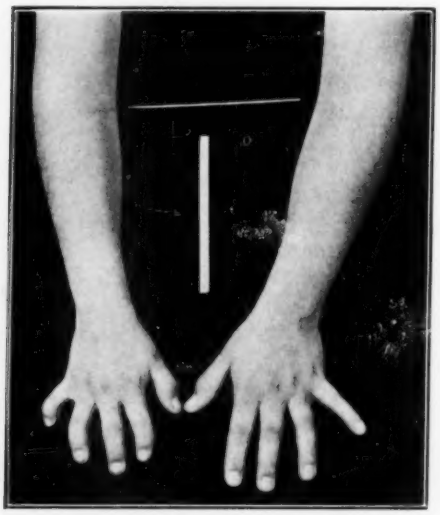

FIG. 4-B

CASE 4. (See Figures 4-A and 4-B.) L. D., aged twelve years, complained of flattening of the right side of the chest which had been noticed since birth.

Physical examination revealed an absence of the pectoral muscles on the right. The right forearm was four centimeters shorter than the left. Syndactylism of the right hand had been repaired surgically, and a good functional result had been obtained. It had involved the middle, the index, and the two small fingers up to the distal phalangeal joints. The right hand was small and the fingers were shorter than those of the left.

The function of the shoulder joint was not impaired in any of the patients, and normal motion was present.

1. BING, ROBERT: Ueber angeborene Muskeldefekte. Virchows Arch. f. path. Anat. u. Physiol., CLXX, 175, 1902.

A METHOD FOR COMPLETE REMOVAL OF THE SEMILUNAR CARTILAGE

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During the author's service at Schofield Barracks he had the opportunity to see an unusually large number of injuries as a result of the stress laid upon athletic activities at that station. He was particularly impressed by the large number of knee injuries among the soldiers, and by the number of days of duty lost because of these injuries. The greatest number of internal derangements of the knee occurred during the football and boxing seasons, and many of these included damage to the semilunar cartilage. In reading the literature and in attempting to find some means of simplifying the operation for the removal of the semilunar cartilage, he found the description of the Lowe-Breck cartilage knife published in *The Journal of Bone and Joint Surgery*.[1] A knife that was a modification of

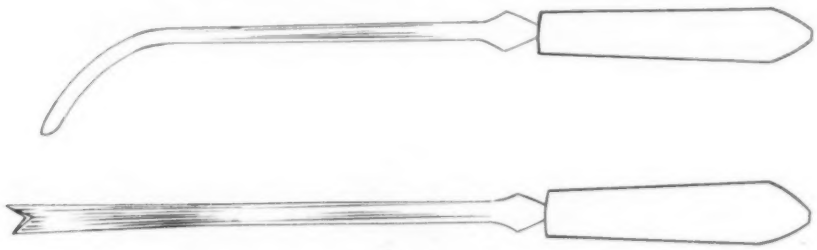

FIG. 1

Modified Lowe-Breck knife.

the Lowe-Breck instrument was made. It appeared that this new knife was simpler in construction and worked just as well. (See Figure 1.)

The Jones incision gave the best exposure of the anterior one-third of the semilunar cartilage, and by freeing the anterior one-third, using a small scalpel, and grasping it with strong forceps for traction, the curved knife was easily slipped around the outer margin of the cartilage, separating it from its attachments with the exception of the very posterior internal segment. The traction forceps was then moved backward to about the mid-position of the cartilage. By a gentle pull on the forceps with one hand, and slight flexion and extension of the leg on the thigh with the other, the cartilage was dislocated into the intercondylar notch. The remaining attachment could then be easily and completely

removed by the use of a turbinate knife, the left turbinate knife being used for the lateral cartilage and the right for the internal cartilage. The blade of the turbinate knife was passed posteriorly and inferiorly to the cartilage which remained in the grasp of the forceps, and through the intercondylar notch, until the blade was well back of the posterior attachment. Taking a firm grip on the knife, and with a slight rotary and forward motion, the cartilage was removed. Care must be taken not to hook the knife back of the cruciate ligaments and sever them.

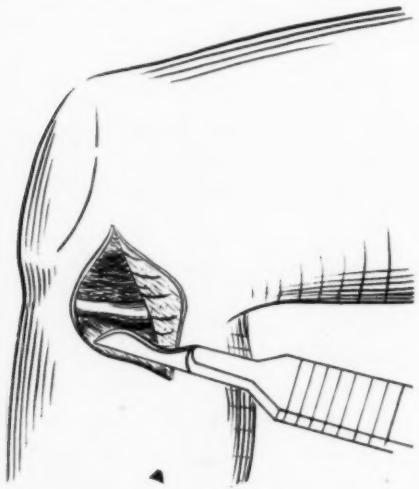

FIG. 2
Anterior horn is freed with a small scalpel.

About fifty patients have been operated upon using this method, and all of them were returned to duty in from two to

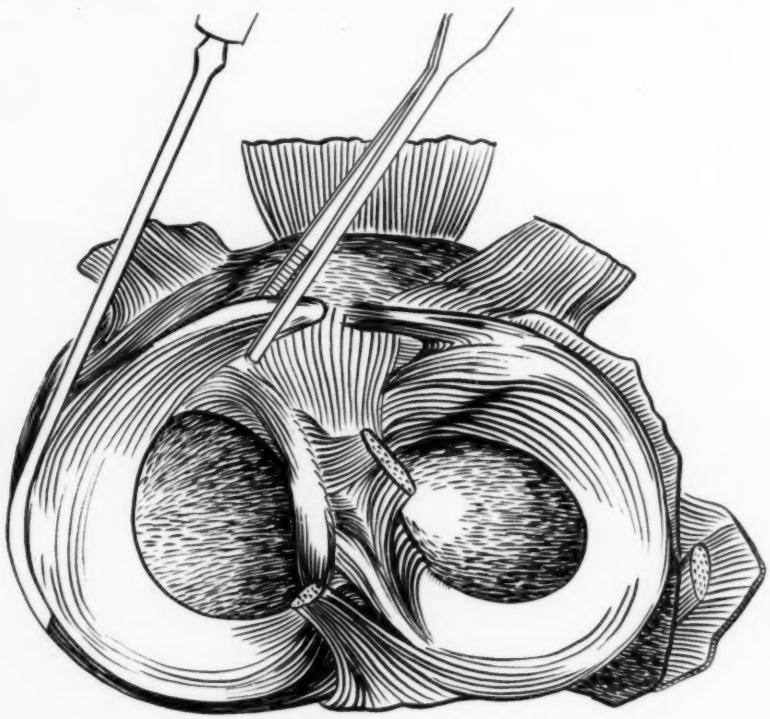

FIG. 3
Curved knife is slipped around the outer margin of the cartilage.

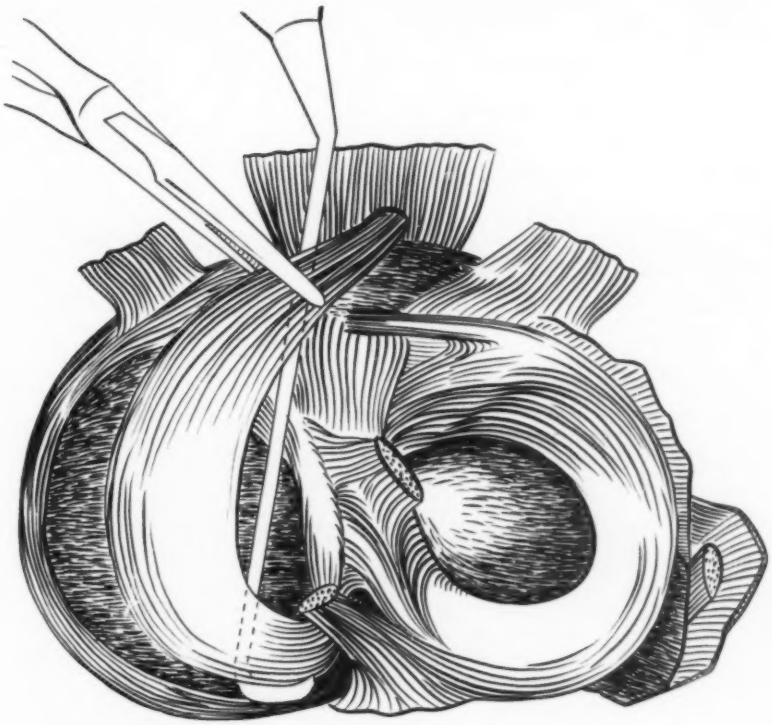

FIG. 4

Cartilage is dislocated into the intercondylar notch. The posterior segment is excised by the use of the turbinate knife.

three weeks. All had complete function restored, and were performing full military duty. It is believed that by using this method the cartilage in its entirety can be removed. The posterior one-third will not be left, as is the case in many instances, and injury to the articular cartilage by the remaining fragments and free margins will be avoided. The smallest amount of damage possible is done to adjacent structures by the use of the curved, turbinate, and operating knives. No injury at all is done to the articular cartilage, as there was formerly when curved scissors were used. These instruments can easily be obtained in any operating room.

This procedure, it is believed, definitely shortens the convalescence by minimizing the residual symptoms, which are thought to be largely the result of trauma incurred during the operation.

The drawings for the illustrations of this paper were made by the Art Department, Medical Replacement Training Center, Camp Barkeley, Texas.

1. LOWE, F. A., and BRECK, L. W.: A New Knife for Use in Removing Semilunar Cartilages. J. Bone and Joint Surg., XX, 220, Jan. 1938.

NON-UNION OF THREE RIBS

BY DARRELL G. LEAVITT, M.D., SEATTLE, WASHINGTON

Non-union or pseudarthrosis of the ribs following fracture is comparatively infrequent and has received little or no attention in the textbooks. Although the author has seen previous instances, he has not observed any case in which there was non-union of more than one rib; and it has been his impression that non-union of the so-called floating ribs is more common.

In the following case, a dense adhesive process on the posterior

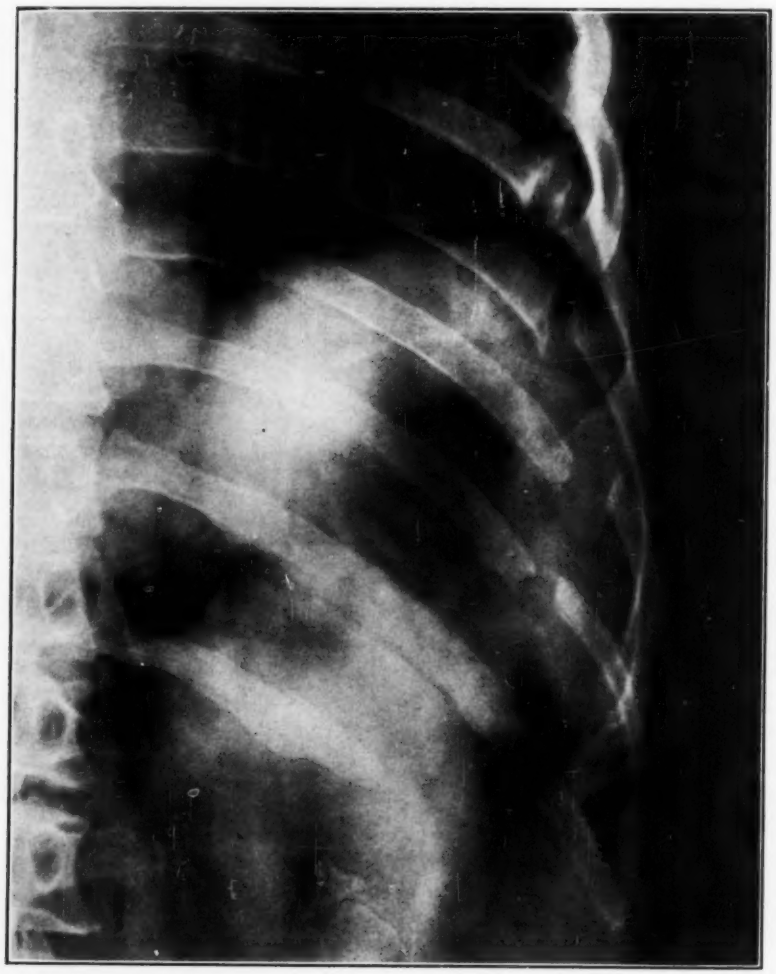

FIG. 1

July 29, 1938. Ununited fractures of the eighth, ninth, and tenth ribs and questionable non-union of the seventh rib.

portion of the diaphragm, demonstrated in an oblique roentgenogram, no doubt produced abnormal excursion of the proximal fragments of the fractures, thus producing an unusual mechanical basis for instability, and preventing union.

CASE REPORT

A man, fifty-three years of age, was seen on July 29, 1938, complaining of discomfort in the left side of the chest and occasional expectoration of blood.

On September 29, 1937, he had injured the left thorax in a severe fall. Adhesive strapping was applied to the chest, and the patient was kept in bed for three weeks. Removal of the strapping was followed by considerable pain in the left side of the thorax, and the patient coughed up blood. There was marked swelling of the left thorax, extending to the base of the neck, which persisted for several weeks.

Examination of the thorax by the author revealed marked impairment of percussion resonance over the posterior lower third, extending to the lateral aspect. There was absence of breath sounds over the area of percussion dullness. A small amount of sugar was found in the urine. Subsequent fasting blood-sugar studies revealed persistent slight elevation only. Consultation with Dr. Byron Francis disclosed an adhesive process between the posterior quadrant of the left diaphragm and the thoracic wall with a mild bronchiectasis.

Roentgenographic examination (Fig. 1) revealed non-union of the eighth, ninth, and tenth ribs with questionable non-union of the seventh rib. Other roentgenograms demonstrated fractures of a number of adjacent ribs, but these were thought to be healed and united in good alignment.

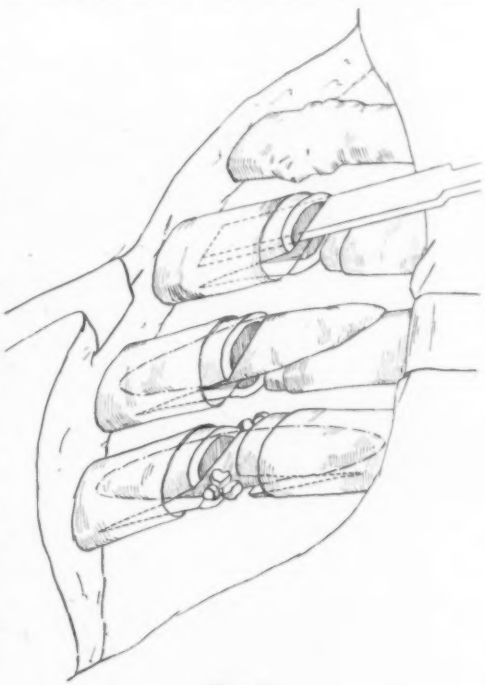

FIG. 2
Diagrammatic sketch of operative procedure.

On October 10, 1938, about one year after the injury, an operation on the left thorax was performed. A long, straight incision was made over the posterolateral thorax, splitting the fibers of the latissimus dorsi in their longitudinal direction. The sites of non-union were then exposed by transverse incision over each rib in its longitudinal direction. This necessitated separating the digitations of the serratus posterior inferior and the periosteum at the ends of the ribs near the sites of non-union. With each expiration and inspiration, marked excursion (from one-half to three-quarters of an inch) was found to exist between the ends of the ununited ribs. There was non-union of the eighth, ninth, and tenth ribs, but the seventh rib was found to be solidly united.

Several methods of producing solid union were considered, but, because of the width of the gap revealed in the roentgenograms, it was decided that a bony bridge should be created. Therefore, three cortical grafts were removed from the right tibia,—each three inches in length and about one-half an inch in width. These were made in the shape of a shuttle. The ribs, having been left mainly covered by periosteum, especially

away from the fragment ends, were freshened; and an osteotome was driven into each end, splitting it into an external and an internal half. (In one area the intercostal artery was severed and had to be tied.) Each graft was driven into one split fragment; the ends of each fragment were then sprung apart and permitted to settle over the protruding end of the graft. Small bone chips were placed about the grafts, and the deep tissues were closed with chromic-catgut sutures. (See Figure 2.) Adhesive support only was used after this operation.

The postoperative course was satisfactory. However, about the fifteenth day some oozing from the wound developed, which seemed to consist of fluid and fat. This cleared up shortly without evidence of wound infection. Marked improvement in the degree of pain was evident at first. There was some complaint of intercostal radiation to the front of the chest. Various roentgenograms showed the tibial bone in position, but it was difficult to determine the presence or absence of union until November 8, 1939, when roentgenograms suggested that non-union existed in the site of the lower graft (Fig. 3).

FIG. 3

One year after operation. Tibial transplants are still dense. There is apparent non-union of the proximal fragment of the tenth rib to its graft.

FIG. 4

January 24, 1941. Solid union of all three ribs. Stainless-steel suture *in situ*.

About this time a prominence appeared in the chest over one end of this graft, which was painful on pressure. There was also increased complaint of local discomfort in the chest at this time.

On November 25, 1939, a second operation was performed, in which the three fractured ribs were exposed as before. The eighth rib had become solidly united. In the case of the ninth rib the graft had united solidly to one of the fracture fragments, but a very narrow stable pseudarthrosis existed between the graft and the other fragment; the graft was still in excellent position, but was sliding slightly in the smooth reciprocal surface of the rib. The graft in the tenth rib was solidly united to the distal fragment and appeared to be viable; but the other end protruded into the soft tissues, having eroded its way out of the proximal fragment. The pseudarthrosis in the ninth rib was freshened. The bone, however, was left in its bed. Cancellous bone from the shaft of the rib away from the fracture site was taken off with an osteotome and placed about the freshened site of non-union. A wire loop was placed about the protruding graft in the tenth rib to hold it closely approximated to the proximal fragment. Here, again, cancellous bone was removed from the rib at a greater distance and packed around this pseudarthrosis.

The trunk was encased in plaster with very little padding, the plaster remaining in place for twelve weeks.

Roentgenographic examination (Fig. 4) on January 24, 1941, showed solid union of all three ribs, with the stainless-steel wire still *in situ*.

This patient was an Industrial Accident case, and the degree of persisting discomfort was difficult to determine. However, he admitted that there had been a great deal of improvement in the pain in the left chest.

SUMMARY AND CONCLUSIONS

Non-union in rib fractures is not common. The case presented suggests that it requires an unusual circumstance, such as the occurrence of dense adhesions between one portion of the chest wall and the adjacent fragments, to produce sufficient excursion of the fragments to result in non-union. In this case tibial bone grafts assisted in securing union, although two operations were required to obtain union of all three fractures. A plaster cast about the trunk is probably advisable after this type of surgery to assist in securing some restriction of trunk, if not thoracic, motion.

LOCAL APPLICATION OF SULFONAMIDES TO SYNOVIAL SURFACES

BY EDGAR M. BICK, F.A.C.S., MAJOR, MEDICAL CORPS, UNITED STATES ARMY, AND HOMER C. PHEASANT, CAPTAIN, MEDICAL CORPS, UNITED STATES ARMY, FORT MONMOUTH, RED BANK, NEW JERSEY

From the Station Hospital, Fort Monmouth

The efficiency with which topical application of sulfonamide derivatives prevents infection in clean traumatic or operative wounds can no longer be questioned. Favorable results in controlling gross infection have been reported and fully confirmed by many investigators. However, investigations of the special activities of these agents, when applied to various tissues, must continue, so that their proper relationship to standard surgical procedures can be ascertained, and their secondary effect on these tissues can be studied.

For the past year, the effect of the sulfonamides, when applied locally, on the process of wound healing and the reaction of the cutaneous and subcutaneous strata to them have been studied on this Service. In reporting upon this study,[1] it was shown that the application of sulfonamides directly to wound surfaces, in the quantities and by the methods which had been recommended by various writers, delayed healing by 50 to 75 per cent. of the anticipated time factor, in both operative and traumatic wounds. Because of this pronounced lag in healing time with high drug concentrations in the superficial tissues, the sulfonamides have more recently been applied by the authors only to the deep tissues of wounds, and have been deliberately kept away from skin surfaces and immediate subdermal areas. In the present series of cases, the amount of sulfonamide topically applied was less than one-half the quantity initially used. This plan of applying the drugs to the deep levels only led to a study of the reaction of synovial surfaces to direct contact with these agents.

In the course of 140 operations on or about joints or tendon sheaths, sulfanilamide was applied directly to synovial tissue in fifty-six cases. Sulfathiazole was used in an additional twenty cases. The remaining sixty-four cases, of comparable range and variety of operations, did not have any sulfonamides administered topically.

The drug was applied to articular synovial tissues in forty-six of the seventy-six cases in which one of the sulfonamides was used, and to synovial tissue of bursa or tendon sheath in thirty cases. These wounds were carefully observed for evidence of any alteration in healing, and more particularly, for evidence of prolonged or residual dysfunction as compared with the rapidity of healing and recovery of function in similar operative wounds not treated with these drugs. One specific group of cases within the larger group, in which such comparison was possible

to a considerable degree of accuracy, was represented by arthrotomies of the knee joint for fracture of a meniscus or osteochondritic lesions. An almost identical Jones, or crescentic, incision was used, of approximately the same length and location in twenty-nine such cases. One of the sulfonamides (usually five grams of the drug), was implanted directly in the knee joint in fifteen cases. This group was compared with a group of fourteen cases of knee arthrotomy in which no sulfonamide was used. As in the general series, no variation in postoperative function or any other alteration in tissue reaction was found, in comparing the two groups, which might have been attributed to the effect of sulfonamide drugs on synovial tissues. In certain of the earlier cases, the additional application of the drug to the superficial tissue layers had impaired and prolonged wound healing, and there was a corresponding lag in complete mobilization of the part. In the present series, follow-up at successive weeks and close comparison of muscle strength, range of motion, and synovial reaction in the treated and untreated knees indicated that no discernible ill effect had resulted from the application of the smaller quantities of sulfonamides to the synovial surfaces of the knee joint. Protection from infection was, moreover, equally effective when these smaller doses were used and superficial cutaneous areas were avoided.

When applied to certain tendon sheaths, such as those of the extensor and flexor tendons at the wrist or fingers, which are relatively closer to the skin surface, wound healing was characterized by persistent swelling and induration at the site of the topically applied sulfonamide, which would recede slowly over a period of from ten days to two weeks. This was evidence of more than normal postoperative tissue reaction, but was not painful. Function in the eighteen patients in whom this reaction was noted compared favorably at the end of one month with a comparable number of patients in the group in whom no drug was used. In the latter part of the series, when the smaller doses were well buried in the deeper layers, healing was more rapid and the degree of induration considerably less.

The question of adequate dosage in local application of the sulfonamide derivative in any area of the body has not yet been determined. It is certain that in the first trials the drugs were used in unnecessarily large amounts. Many surgeons no longer pack the wounds with the drug. Spraying or otherwise completely covering the exposed surfaces of a wound or incision is, according to the authors' experience, equally unnecessary. With smaller doses of these drugs, there is less proliferation of subcutaneous fibrous elements, and wound healing more closely approximates that of primary union in wounds not exposed to the local sulfonamides. This is particularly important around articular or tendon-sheath areas where large amounts of the drug, in retarding superficial wound healing, prevent the active motion necessary to insure proper function of the restored synovial surfaces.

In comparable Jones incisions, the amount of sulfonamide has varied from ten grams to three grams, introduced well within the joint cavity.

There have been no infections and no residual functional differences except, as remarked above, that the larger doses tended to delay wound healing. In most cases, five grams were implanted in the knee joint. Amounts ranging from ten to five grams of the drugs have been placed about and within the tendon sheath of the long head of the biceps brachialis in tenodesis operations at the shoulder. Here, too, the smaller doses have been equally effective. For a wound on the finger, from five-tenths to one gram has been found sufficient to prevent infection and to permit early union without undue fibrosis, and still not to interfere with normal recovery of tendon function.

No differences in the effect of sulfanilamide or sulfathiazole could be found as to susceptibility to infection, joint or tendon-sheath reaction, the rate of wound healing, or the functional result. Both were completely effective in preventing infection. At present, the authors are using only sulfanilamide, because it is easier to handle. Moreover, due to its slower solubility, this drug maintains its local effect for a longer period of time. This observation must not be interpreted as applying to the use of the drugs by mouth. The respective indications when used by mouth are reasonably specific.[2] Apparently with the local-tissue concentrations attained by topical applications, the bactericidal effect of either drug is sufficient to prevent infection. Furthermore, the dosage and relative toxicity of the drugs, when given by mouth, require consideration of the harmful general reactions which do not occur when dealing with topical applications of the quantities used on synovial surfaces.

CONCLUSIONS

1. Topical application of sulfonamide derivatives to the deep tissues in traumatic wounds or surgical incisions, avoiding the skin and the immediate subcutaneous areas, have been just as effective in preventing infection as when sprayed or otherwise spread over the entire wound area. This has been specifically observed in applications to the articular, tendon-sheath, and bursal-synovial tissue.

2. In general, far smaller doses than are usually recommended have been found adequate, and do not significantly retard healing.

3. Sulfonamide derivatives can be applied safely to synovial tissues of joint cavities and bursae or tendon sheaths. When reasonably small quantities are used, no residual adhesions, fibrosis, or other alterations occur, which are not found in similar lesions treated without these drugs.

4. In topical applications to joints or other synovial surfaces, sulfanilamide and sulfathiazole are entirely effective, and can be used interchangeably. Sulfanilamide, because of its smoother handling and greater local staying power, is recommended as the sulfonamide of choice.

REFERENCES

1. Bick, E. M.: Observations on the Topical Use of Sulfonamide Derivatives. J. Am. Med. Assn., CXVIII, 511, Feb. 14, 1942.
2. Bick, E. M.: Sulfone Chemotherapy in Hematogenous Osteomyelitis. Surg. Gynec. Obstet., LXXII, 995, 1941.

A CASE OF XANTHOMA OF THE KNEE JOINT

BY D. H. O'DONOGHUE, M.D., OKLAHOMA CITY, OKLAHOMA

In 1939, DeSanto and Wilson [1] reported an excellent series of xanthomatous tumors of the knee joint, in which they listed thirty-two cases from the literature, and added nine cases of their own. This is a report of one more case. DeSanto and Wilson commented that no case had been diagnosed preoperatively, and the author regrets to say that his case proved to be no exception.

Mrs. M. L., aged thirty-four, white, was examined on May 11, 1940, at which time she reported that two months before, she had attempted to push a buffet drawer shut with her knee. The foot was turned out and as she was pushing inward with her knee, she felt severe pain in her knee, not localized. There was no swelling, and the pain decreased, so that in a day or so, the knee was practically free from pain. Two or three weeks later, she began to feel something slipping in the knee and at intervals, the knee would catch, so that she could not extend it beyond about 150 degrees. She would then twist it around to get it back in place. This happened many times, without any particular swelling of the knee. Two nights before she was examined, she had acute pain in the knee, and was unable to walk on the leg. Hot packs gave some relief. On examination, there was moderate swelling of the knee, no effusion, and tenderness in the line of the joint, medial to the patella. External rotation of the flexed leg caused pain at the anterior insertion of the medial meniscus. Abduction of the flexed knee caused no complaint, nor did adduction or internal rotation. There was no instability of the knee. There was slight tenderness over the anterior end of the medial meniscus. Roentgenographic examination was negative. The diagnosis at this time was fracture of the medial meniscus, and was based largely upon the history of the type of injury which had been followed by repeated episodes of locking. Operation was advised, and carried out June 4, 1940.

Operation: The usual small curved incision was made; the capsule was opened; and a moderate amount of distinctly yellowish, cloudy fluid was drained out. This was definitely more yellow than normal. The medial portion of the fat pad was found to be markedly congested and inflamed. The fat had a more yellow appearance than normal. There were adhesions running from the fat pad back to the intercondylar notch of the femur. Both the adhesions and the area of their attachment showed marked congestion. There was, also, a marked localized synovial irritation. In the medial portion of the joint, there was a tumor, one inch by three-quarters by one-half inch, which had a very small, apparently synovial pedicle, one-half inch long, extending down and attached to the fat pad adjacent to the synovial membrane. This attachment was at the anteromedial aspect of the tibia, at the level of the medial border of the patellar tendon. The tumor was excised, and the pedicle tied off. A considerable portion of the fat pad was removed, because of inflammation and redundancy. This portion included the adhesions which passed back to the intercondylar notch. The menisci were explored and found to be entirely normal. There was slight synovial irritation of the rest of the joint, but this was not marked, the reaction appearing to be localized largely around the area adjacent to the tumor. The usual closure was carried out, and a cotton cast and adhesive strips were applied. The tumor which had been removed was examined and found to be very fibrotic; on cutting through it, there were large yellowish areas scattered through an apparently fibrotic tumor mass. Due to the yellow character of the fluid and the yellow areas through the tumor itself, a postoperative diagnosis of xanthoma was made.

Postoperative Course: The patient was placed in bed with four pounds of traction and

a cotton cast for pressure. At the end of six days, the wound was entirely clean, the adhesive strips were removed, the traction left off, and the cotton cast reapplied. She wore this another five days. Fourteen days after operation, she had range of motion of 90 degrees without pain, and twenty-eight days after operation, there was normal range of motion with no pain or effusion. She was advised to wear an elastic bandage, and progress has been entirely satisfactory. She has been under constant observation since that time; in the first few weeks, she had a sensation of sticking or catching in the joint, although she never had any actual locking. With the exception of one instance, in April 1941 when she had some pain following a minor sprain, the knee has been in excellent condition. Examination of the knee on May 22, 1942, revealed a normal appearing knee; the scar was well healed; and there was a normal range of motion, no instability, and no tenderness. There was a moderate degree of crepitation of both knees, which did not appear to be worse in the one which had been operated upon. Her recent history has been entirely negative, and there is no evidence of any recurrence.

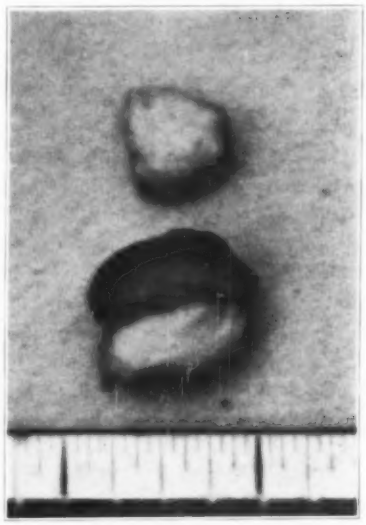

FIG. 1

Xanthoma of the knee, (longitudinal section).

Pathological Report: "The gross specimen consists of: (1) an ovoid pinkish-gray, encapsulated, semifirm tumor, 20 by 10 millimeters. The cut surface is perpendicular, grayish-yellow, and firm; and, (2) an irregular ragged piece of tissue, which is of fatty consistency, 30 by 10 millimeters. Microscopic examination, June 11, 1940, shows a tumor composed predominately of pink-staining, dense, hyaline-type stroma; and bundles, groups, and streams of small oat-shaped cells. Internuclear material predominates throughout and some areas contain small tumor-type giant cells. An occasional, poorly circumscribed area is xanthomatous. Microscopic diagnosis: Benign synovioma with xanthomatous degeneration. This is in keeping with the so-called xanthoma of the synovium."—*H. Jeter.*

In this case of xanthoma of the knee, the tumor was solitary, pedunculated, and well delineated. The patient had an unusually prompt recovery following operation, and apparently, at the present time, has a normal knee. She has been advised of the possibility of recurrence and will be observed for any such development. The author wishes to emphasize, again, the extreme similarity of the symptoms of these discrete tumors to those of rupture of the medial meniscus.

1. DESANTO, D. A., AND WILSON, P. D.: Xanthomatous Tumors of Joints. J. Bone and Joint Surg., XXI, 531, July 1939.

ACUTE OSTEOMYELITIS OF THE PATELLA

A Case Report

BY HENRY T. KIRBY-SMITH, M.D., SEWANEE, TENNESSEE

From the Emerald-Hodgson Hospital, Sewanee

Osteomyelitis of the patella is an unusual condition; only sixty cases have been reported. The literature on the subject consists largely of the reports of isolated cases, inasmuch as in only a few instances has one man had the opportunity of treating more than a single case. The condition is sufficiently rare to justify offering one other case for record.

The patient, a white boy, seven years old, the son of a farmer, was first seen on June 2, 1939. According to the history, on May 12, an infected area had appeared on the right ankle; it had gradually spread and had become more painful. After a week the foot and ankle were red and swollen, and there was a tender mass in the right groin. On May 21, the left knee had become swollen, red, and so painful that the patient had been unable to walk. A slight improvement had occurred during the next twelve days, but the patient was still unable to walk when first examined.

Examination showed a thin, pale boy who did not appear to be acutely ill. The temperature was 99 degrees, and there was evidence of a subsiding infection on the right ankle. The left knee was red and swollen, and although motion was painful, the patient

FIG. 1-A FIG. 1-B

June 29, 1939. Roentgenogram of the patella taken forty days after the onset of the infection, showing the moth-eaten appearance.

was able to flex and extend the knee to a slight degree. An enlarged lymph gland was felt in the left groin. The knee joint was aspirated and ten cubic centimeters of turbid fluid was obtained. No organisms were discovered in a stained smear of the joint fluid.

A diagnosis of acute arthritis of the knee joint was made at this time. Treatment consisted of rest in bed and the administering of sulfanilamide. Ten cubic centimeters of fluid from the joint again failed to show organisms.

On June 10, a red, semi-fluctuant area was noted over the patella. On June 12, under local anaesthesia, an incision was made, and pus was obtained. Smears of the pus showed staphylococci in large numbers. The wound continued to drain for seventeen days, and, because of the prolonged drainage, roentgenograms (Figs. 1-A and 1-B) were made on June 29 which revealed a moth-eaten, fragmented patella. A diagnosis of osteomyelitis of the patella was made, and operation was advised.

On July 10, under ether anaesthesia, the wound was enlarged transversely. It was found that the patella had disintegrated into three pieces which were lying free and unattached in a cavity lined with granulation tissue. The pieces were removed from the cavity. Gentle exploration of the cavity resulted in breaking through the posterior wall into the knee joint. From this opening a thick, mucuslike fluid escaped. The opening in the patella bed was enlarged, and rubber-tissue drains were inserted through the opening and brought out through the stab wounds, on either side of the knee joint anteriorly. Following the operation, drainage continued.

At the end of two weeks the drains were removed. Drainage gradually subsided, and on August 13, 1939, the wound had completely healed. At this time the swelling had somewhat diminished and motion had improved.

The patient was seen every three to four months, and when last seen in October 1941, almost complete function had returned to the joint, there being approximately 5 degrees of limitation of extension. There was no pain resulting from active

FIG. 2-A FIG. 2-B

September 13, 1939. Roentgenogram of the knee sixty-five days after operation, showing the absence of the patella.

or passive motion. Roentgenograms showed bony regeneration of the patella, although it was larger than normal and very irregular in shape. Palpation revealed a large flat, rubbery mass in the region of the patella, which felt like cartilage and which measured two and three-eighths inches by two inches, in contrast to the measurements of one and three-quarters inches by one and three-quarters inches of the normal patella of the right knee.

FIG. 3-A

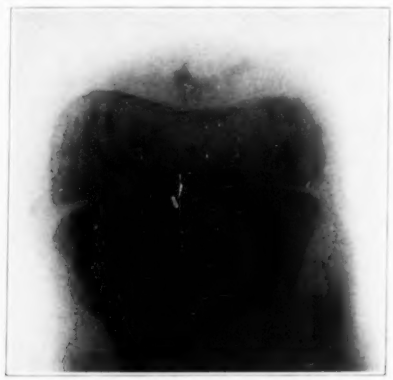

FIG. 3-B

May 31, 1940. Roentgenograms, taken ten and one-half months after operation, show the regenerated patella which is very irregular in outline.

REFERENCES

CHESKY, V. E.: Primary Osteomyelitis of the Patella. Report of a Case and a Review of the Literature. Surg. Gynec. Obstet., XXXVI, 398, 1923.

CHRISTOPHER, FREDERICK: Acute Osteomyelitis of the Patella. J. Bone and Joint Surg., XV, 1012, Oct. 1933.

DITTRICH, R. J.: Osteomyelitis of the Patella. Report of Two Cases. J. Bone and Joint Surg., XX, 209, Jan. 1938.

FLACK, F. L.: Primary Hematogenous Osteitis of the Patella. J. Am. Med. Assn., CVIII, 2199, 1937.

MANCLARK, R. A.: Osteomyelitis of the Patella. Lancet, I, 416, 1933.

MARTIN, J. R., AND HORWITZ, N. T.: Osteomyelitis of the Patella. Am. J. Surg., XXIX, 287, 1935.

MOORE, THOMAS: Acute Osteomyelitis of the Patella. Lancet, I, 552, 1938.

MÜLLER, W.: Die acute Osteomyelitis der Gelenkgebiete. Deutsche Ztschr. f. Chir., XXI, 455, 1885.

MUMFORD, E. B.: Primary Osteomyelitis of the Patella. Case Report. J. Orthop. Surg., III, 583, Nov. 1921.

NORTH, N. H.: A Case of Primary Haematogenous Osteomyelitis of the Patella. New Zealand Med. J., XXXIII, 376, 1934.

SAGEL, JACOB: Acute Osteomyelitis of the Patella. A Case Report. J. Bone and Joint Surg., XVI, 959, Oct. 1934.

STELLA, M. E.: Acute Osteomyelitis of Patella. Am. J. Surg., XXXII, 373, 1936.

News Notes

The Annual Meeting of **The American Academy of Orthopaedic Surgeons** is scheduled to be held at the Palmer House, Chicago, January 17 to 21, 1943.

The 1942 Clinical Congress of the **American College of Surgeons,** originally scheduled for October at the Stevens Hotel, Chicago, which has been taken over by the United States Army Air Corps, will be held in Cleveland, November 17 to 20. Headquarters will be at the Cleveland Public Auditorium. The Hospital Standardization Conference, sponsored by the College, will be held simultaneously.

Colonel Norman T. Kirk has been relieved from duty as Chief of the Surgical Service at Walter Reed General Hospital, Washington, D. C., and ordered to command the Percy Jones General Hospital, Battle Creek, Michigan.

Dr. Harold A. Sofield, of 715 Lake Street, Oak Park, Illinois, announces the association with him of Dr. Manley A. Page in the practice of orthopaedic surgery.

Dr. Paul C. Colonna, who has been Director of the Department of Orthopaedic Surgery at the University of Oklahoma School of Medicine for the past four years, has been appointed Chief of the Department of Orthopaedic Surgery at the Hospital of the University of Pennsylvania, and Professor of Orthopaedic Surgery in the Medical School. He entered upon his duties in Philadelphia on August 1.

The Fifth Annual Congress of the **Sociedade Brasileira de Ortopedia e Traumatologia** was held June 30 to July 3, 1942, at Rio de Janeiro. Two of the important subjects for discussion were Obstetrical Paralysis, and Internal Derangement of the Knee. One session was devoted to War Traumatology, and various officials of the Army, the Navy, and the Department of Aeronautics participated. An interesting feature of the meeting was the exhibition of surgical instruments and orthopaedic apparatus which was held in the Hall of the National Academy of Medicine.

An appeal to those interested in poliomyelitis is made by Dr. H. C. Elliott of the Department of Anatomy, University of Toronto, Toronto, Canada. Under a grant from the United States National Research Council, research is being carried on which requires complete spinal cords of acute cases where death has occurred from the disease itself, and, even more particularly, of chronic cases in which death has resulted from other causes some time after paralysis. A promising line of attack is being seriously hampered by lack of material. Cords from acute and particularly from chronic cases are required. Even a single cord would be of great value.

Specifications call for intact cords or intact upper or lower halves. The dura should be left on, but may be slit up the back. The cord may be cut into three equal lengths. Fixation should be straight, preferably with 2-per-cent. glacial acetic acid in 95-per-cent. alcohol, but may be with formol saline; about a pint of the solution should be used. Up to $10.00 can be provided for technical assistance in removing a cord. Sections required for use of donor will be prepared, if desired, as cord must be intact on receipt.

The Commonwealth Fund of New York, a philanthropic foundation established in 1918 by the late Mrs. Stephen V. Harkness, announces that it is offering through the **Pan American Sanitary Bureau** fifteen fellowships for one year's study of public health subjects or postgraduate medical courses to properly qualified persons who are citizens of the other American republics. Fellowships in public health will be open to

physicians, sanitary officers, technicians, public health nurses, etc. Each fellowship will provide living allowances while the holder is in the United States, travel costs, and tuition. Knowledge of the English language will be among the requirements, and also the possession of certain specific qualifications.

Application blanks giving complete information will be available through the Commonwealth Fund, 41 East 57th Street, New York; the Pan American Sanitary Bureau, Washington, D. C.; or chiefs of the American Missions in Latin America.

Readers of *The Journal* are invited to contribute material to the **Treasury of Science.** This new series of low-priced, pocket-sized books is designed to serve the student and the reading public interested in the sciences and ready to devote intelligent effort to their understanding. The books will be introductory volumes to their subjects. The Board of Editors includes Prof. Harlow Shapley, of Harvard University; Dr. Alvin Johnson, Director of the New School for Social Research; and Dr. Alfred E. Cohn, of the Rockefeller Institute. Correspondence about manuscripts should be addressed to the Treasury of Science, L. B. Fischer Publishing Corp., 381 Fourth Avenue, New York, N. Y.

Word has just been received of the death of Dr. Charles Hope Jaeger, of Greenwich, Connecticut, on September 12. Dr. Jaeger was for many years consultant in orthopaedic surgery at the Lenox Hill Hospital, New York City. His work on congenital dislocation of the hip is well known. Dr. Jaeger was an Emeritus Member of The American Orthopaedic Association.

THE BRITISH ORTHOPAEDIC ASSOCIATION

The Spring Meeting of **The British Orthopaedic Association** was held in Liverpool, May 29 and 30, under the presidency of Mr. G. R. Girdlestone, of Oxford.

In the discussion of the subject "The Delayed Union of Fractures", most of the speakers remarked on the generally held impression that delay in union is more common than formerly. Many of them mentioned the difficulties of the statistical approach, both in deciding upon a standard of "union" in the consideration of the time factor, and in comparing fractures of the same bone due to different types of violence. There was agreement in stressing the evils of late reduction, of distraction, and of infection.

Mr. George Perkins, Roehampton, differentiated between "union" when the fracture was solid, and "consolidation" when it had progressed to the state of ability to withstand normal stresses. He emphasized the importance of restoration of function and the need for muscle activity from the outset of treatment. He was convinced that fractures take longer to repair than they did and that there is something wrong with present-day treatment. He felt that prolonged rigid immobilization of fractures has been overemphasized, with undue attention to distraction at the expense of the compression stress exerted on fracture surfaces by muscle action.

Mr. R. Watson-Jones, Liverpool, and Squadron-Leader W. D. Coltart, R.A.F., presented a detailed analysis of 500 shaft fractures of the femur and tibia treated in Royal Air Force Orthopaedic Units. They felt that the factors responsible for delay in the union of these fractures had been: (a) infection, which trebled the union time; (b) distraction of the fragments by excessive skeletal traction, which caused very marked indolence of the fracture surfaces and doubled the union time; (c) delayed reduction, late remanipulation, and, in the case of the femur, late bowing or refracture, which almost doubled the union time. In the absence of these delaying influences, fractures united firmly enough for the removal of splints and plaster in an average time of fourteen weeks. Union, as shown by clinical tests, had often been present earlier than this, but immobilization had been continued in walking plasters until consolidation could be proved by roentgenogram. The early resumption of weight-bearing in a walking plaster was a delaying factor in cases where minor angulation remained, as it tended to increase the

angulation momentarily and thereby distract the fractured surfaces on the open side of the fracture.

If it was recognized that union had been delayed by infection, distraction, late remanipulation, etc., and the period of plaster immobilization had been extended accordingly, these factors were responsible only for slow union and not for non-union. In this series of cases, where complete and uninterrupted immobilization had been maintained, there was not a single instance of established non-union. In eight cases, early bone-grafting had been performed to accelerate the rate of repair, but in the whole series there was not one single case of sclerosis of the fractured surfaces and established non-union, despite a high proportion of grossly contaminated and infected fractures. Ten per cent. of the patients were invalided; 90 per cent. returned to duty.

Mr. B. H. Burns, London, believed that the advantage of the more accurate anatomical position maintained in the modern unpadded plaster cast was possibly counterbalanced by the longer time that appeared to be taken in reaching union. Well-planned open reduction in selected cases offered perfect anatomical restoration, with greater freedom of the soft parts, earlier weight-bearing, and early union.

Dr. E. Harlan Wilson, Columbus, Ohio, was of the opinion that the type of initial violence might account for the greater time taken for recovery from motorcycle injuries, where speed of impact was noteworthy. He believed that damage to the vascular supply of bone had great bearing on the time of healing. He remarked on the frequency of delayed union in cases of multiple fractures with their greater demands upon the body's osteogenetic functions. In his experience with the Roger Anderson method of treatment he found it subject to the same conditions and time of fracture healing as other methods.

Major A. W. M. White, R.C.A.M.C., Toronto, Canada, believed that the factors most likely to affect the rate of union are the apposition of the fracture surfaces and complete and continuous immobilization. In 120 cases of fracture of the tibia, of which he had made a survey, reduction was considered adequate when roentgenograms showed that 75 per cent. of the fracture surfaces were in apposition. In fifty-one well reduced and immobilized leg fractures, the average time for union was four and a quarter months, whereas in thirteen inadequately reduced or poorly immobilized cases it was eight and a quarter months. Bone-grafting had resulted in union in 96 per cent. of the cases, but rehabilitation seemed to take longer than in the cases of union without grafting.

Mr. D. L. Griffiths, Manchester, made a determined plea for inquiry by statistical methods. He had submitted 249 cases of fracture of both bones of the leg, with displacement, to such inquiry. His conclusions were that open fractures heal more slowly than closed fractures, the two forming distinct groups, and that direct violence, severe violence, and inadequate apposition of the fragments are all delaying factors. Figures indicate that only the grosser errors of treatment are important in delaying union.

Mr. F. W. Holdsworth, Sheffield, reported from a study of 399 cases of fracture of the leg, treated throughout by his own team, that 349 returned to their former occupations and thirty-five to modified work. Only fifteen had very poor function. In 303 adults, 102 compound fractures united in an average of sixteen and one-half weeks (the longest period, twenty-eight weeks, was required in four cases), and the remaining closed fractures united in an average of thirteen weeks. He stressed concentration on end results rather than on the time taken to reach them. Continuity of treatment by one unit was an essential requirement. He and other speakers deprecated the late reduction occasioned by the slow movement of patients from one hospital to another.

Dietetic factors were discussed by Mr. R. I. Stirling, Edinburgh, with particular reference to the important part played by vitamin C.

On the second day of the meeting, a discussion was held on "Amputations", based upon the different views held by surgeons in Canada and in Great Britain. The former attitude was stated by Dr. LeMesurier, of Toronto. The preference of Canadian surgeons for end-bearing stumps for leg amputations was founded upon the results, and upon the superiority of stumps of this type as compared with those depending upon lateral bearing in the socket of an artificial limb. The speaker's remarks dealt more particu-

larly with Syme's amputation, which he was surprised to find so universally condemned in Great Britain. Although he had heard about the defective circulation in a Syme's stump, he had seen very little of it. On the contrary, he had found that the skin of such a stump was much more satisfactory for weight-bearing than was that upon the sides of the tibial condyles. He felt that a great deal of the success of the Syme's amputation depended upon careful technique at the time of the operation. Dr. LeMesurier believed that the Canadian choice of Syme's stumps was not influenced in any way by the type of artificial leg used. An important question to be settled is the length of time that a Syme's stump can be expected to stand up under the constant strain of weight-bearing. The Ministry of Pensions had reported that of fifty-four such cases followed between 1918 and 1933, re-amputation at a higher level had been necessary in thirty-eight. In Toronto, however, of a series of fifty-three cases, not a single Syme's stump had required re-amputation since 1922, and twenty of these patients were operated upon prior to that year. The stumps were excellent.

Dr. R. H. Kelham, Roehampton, explained the views of the limb-fitting surgeons for the Ministry of Pensions. He remarked on the large number of Syme's amputations performed in the last war, with re-amputation necessary later at a higher level. Many of these patients had been unable to tolerate end-bearing for more than eight years, and of those who had undergone re-amputation, not one failed to express his gratitude at being provided with a stump which gave complete confidence. A particular advantage was the better appearance of the limb, which is of importance to a woman.

Mr. W. A. Cochrane, Edinburgh, made a plea for further consideration by British surgeons of the advantages of the Syme amputation.

In a paper on "Intertrochanteric Fractures", Mr. Norman Capener, Exeter, described the use of gimlets inserted into the femur and incorporated in plaster. This is a simplified application of the Roger Anderson method.

A paper was read by Prof. H. J. Seddon, Oxford, on "The Rate of Regeneration of Peripheral Nerves in Man". It has long been believed that the rate of regeneration is about one millimeter a day, although exact determinations have never been made. There are three possible methods of investigating these rates:

1. Serial reinnervation of muscles. If the level of a lesion is known, as well as the points of entry into muscle of the various motor branches below the lesion, and the time of appearance of the first contraction in each muscle, then it is possible to construct a graph, showing the rate at which the process of regeneration spreads down a nerve trunk. A number of estimates made in this way showed that the rate after complete division was probably slower than after a lesion in continuity (axonotmesis). The difference was in the rate itself, and not merely in the delay at the site of the lesion or at the motor end-organs. Stopford's data from the last war, analyzed in this way, gave a rate for sutured nerve of six-tenths millimeters a day (radial nerve); but in axonotmesis (almost all cases of radial-nerve injury occurring in closed fractures of the humerus), the rate was one and four-tenths millimeters a day in the author's cases.

2. The return of sensibility in a long zone of skin innervated by one nerve can be worked out in a similar way. The rate for the return of pain sensibility was found to be about one and two-tenths millimeters a day.

3. Observations have also been made on the rate given by Tinel's sign, — reliable only in cases of suture, and then only when it moved down the nerve with reasonable regularity. The sign corresponds fairly closely with the position of the wave front of fibers and is due to direct stimulation of the fiber tips. It is only to be expected, therefore, that the rate of progress is faster than are rates dependent upon functional maturation. In the few complete observations that have been made, the rate was found to be 1.78 millimeters a day.

Mr. W. S. Diggle, Liverpool, presented a cinematographic demonstration of "The Treatment of Fractures of the Shaft of the Femur on the Thomas Splint".

Improved methods of obtaining "pneumo-arthrograms" in lesions of the semilunar cartilages were described by Dr. C. H. Cullen and Dr. G. Q. Chance, of Warrington.

Seventy to 140 cubic centimeters of filtered air was injected into the suprapatellar pouch, the injections being continued until the patient felt his knee to be definitely tight. A crepe bandage was bound tightly above the patella, to force air into the lower part of the joint. Two principles were stressed: (1) The part to be x-rayed should always be uppermost, to allow the maximum amount of air to fill the area under examination; and (2) the x-ray tube should always be horizontal so that the central beam will pass through the segment of cartilage being examined. Dr. Chance had a series of cross-sectional views taken of each cartilage. In practice, these views are tangential in projection. A higher percentage of accurate preoperative diagnoses was claimed for these methods of pneumoarthrography.

On Friday afternoon, May 29, the members and guests visited the R.A.F. Rehabilitation Centre, at Hoylake, by permission of the Air Ministry. Mr. Watson-Jones gave a clinical demonstration at which he stressed the importance of carefully graduated muscle exercises, carried out initially under the guidance of the Medical Officer and later in the gymnasium under the control of physical training instructors and masseuses, and the value of various outdoor games in which the competitive team spirit was encouraged. The meeting was then addressed by Flight-Lieutenant Cantor who described the working of the Centre and the importance of keeping the patient's treatment under the close supervision of a medical officer. Squadron-Leader Dawes, the Commanding Officer, emphasized the importance of recreating mental and moral fiber in addition to restoring patients to full physical fitness.

The next meeting of The Association, the Annual Meeting, is scheduled for the early fall.

Current Literature

THE HAND. ITS DISABILITIES AND DISEASES. Condict W. Cutler, Jr., M.D., F.A.C.S. Philadelphia, W. B. Saunders Co., 1942. $7.50.

This book of 572 pages and 274 illustrations covers many aspects of the care of the hand. The hand is one of man's most useful members, and also one commonly injured. Trauma is often followed by infection. Due to the multiplicity of its structures, treatment of sepsis of the hand may task the surgical skill of those proficient in that field. It is unfortunately true that a majority of hand injuries and infections are of necessity first seen and often treated by physicians possessing meager experience with those problems. Upon the judgment used at the first treatment may depend the chances of a successful outcome. Since the prognosis in hand surgery may be grave under the best circumstances, a clear exposé of the subject is valuable to any physician, specialist, or practitioner, who is liable to be confronted with this problem.

This book fulfills well the requisites of a practical guide for the diagnosis and treatment of hand conditions. There is a chapter covering the anatomy of the hand, clearly illustrated by pictures and drawings. This is followed by a chapter on infections, which emphasizes the influence that anatomy plays in sepsis of the part. The care of special infections is also taken up.

Since trauma and sepsis form but a small part of hand disabilities and diseases, chapters follow on the subjects of burns, abrasions, contusions, puncture wounds, and foreign bodies. The treatment of incised and lacerated wounds, including injury to blood vessels, nerves, and tendons, is covered. Several methods of tendon and nerve suture are illustrated by drawings.

Fractures, dislocations, and amputations, including the management of compound fractures, are discussed. Repair and reconstruction procedures for restoration of function are given. Congenital deformities and tumors which may occur in the hand are reviewed. The effect of constitutional diseases, as reflected in the hand, is described. In fact, about every phase of hand disease has been thoroughly covered. Discussions have been well amplified with clear, pertinent drawings and illustrations. The book is what the author wished it to be,—a useful guide for those whose task it is to deal with the diagnosis and treatment of hand conditions.

DISABILITY EVALUATION. PRINCIPLES OF TREATMENT OF COMPENSABLE INJURIES. Earl D. McBride, M.D. Ed. 3, Revised. Philadelphia, J. B. Lippincott Co., 1942. $9.00.

The preface to this book of over 600 pages states, "The purpose of this volume is to interpret the physiological and mechanical alterations arising out of injury to the motor structures of the human body, and to reasonably appraise and evaluate the extent of functional loss as it relates to the economic incapacity of the injured".

The just compensation of industrial accident and other cases of medico-legal injuries requires, as McBride has pointed out, a very careful medical analysis of each case. He has set up an elaborate "composite schedule of approximate evaluations for partial permanent disability", which takes into account many variables. Among them are age, multiple disabilities, occupation, and member involved. He arrives at the percentage of functional impairment of an injured member by assigning arbitrary weighted values to seven factors, the sum of which, in the case of total loss of use, would equal 100 per cent. These factors are: (1) delayed action, (2) awkwardness, (3) weakness, (4) insecurity, (5) diminished endurance, (6) lowered safety factor, and (7) adverse influence of conspicuous impairment.

This attempt to reduce disability evaluation to something approaching mathemati-

cal exactitude is certainly to be commended. However, the author's method seems unduly complex, and for that reason may not find general acceptance. It at least challenges critics to produce a better one.

Following the section devoted to the more general aspects of disability evaluation, there is a chapter in which an attempt is made to enumerate all the multitudinous factors encountered in a complete history and physical examination of a disabled person.

A section of ten chapters is devoted to joint stiffness, and one of similar length to fractures, in which there is a mathematical treatment of skeletal mechanics. Chapters on The Industrial Back, The Trunk, Nerve Injuries, Amputations, Head Injuries, Injuries of the Eye, Injuries of the Ear, Burns, and Hernia complete the book.

The volume is attractive in format and typography, and is profusely illustrated with line drawings, photographs, and roentgenograms.

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. John Albert Key, B.S., M.D., and H. Earle Conwell, M.D., F.A.C.S. Ed. 3. St. Louis, The C. V. Mosby Co., 1942. $12.50.

The number of books on fractures in the English language is not small. There are, however, very few which are modern and comprehensive, and which can be used as a practical working guide in the management of fractures, dislocations, and sprains.

The book received immediate recognition as an outstanding contribution when first published in 1934. Revised in 1938 and again in 1942, it has kept as nearly abreast of current practice as can reasonably be expected of any text. No other clearly surpasses it, and this reviewer feels that Key and Conwell lead the field. This volume has earned its place on the reference shelf of every one who treats fractures. The present edition contains revisions in the chapters on fractures of the spine, humerus, hip, and foot. The chapter on compound fractures has been rewritten, and contains a section on war wounds. The principles laid down are in accord with sound modern surgical practice, though every critical reader will find details and techniques recommended, which he would alter or discard for others better suited to his taste.

VOIENO-POLEVAIA KHIRURGIYA (War Field Surgery). Prof. M. N. Akhoutin (Peoples' Commissariat of Health of the U.S.S.R.). Moscow, "Medgis", 1942.

Books on field surgery may become obsolete before they reach the reading surgeon. The author is well aware of this fact. However, this book, written by a participant of the recent Russo-Japanese and Finnish conflicts, may be of great interest to the military surgeon. Most of the experiences are based on a rather stable front line, which permitted surgical interference in a large percentage of the cases within the safe period of time. But in spite of this, the general character of the book and the wealth of accumulated experience are of such nature and flexibility that it may be used with profit in any military situation. Although the author refers frequently to other sources, the book is a record of personal views and work.

It is divided into eighteen chapters encompassing most of the important questions of field surgery. The first chapter is devoted to the problems of organization of first aid, surgical treatment, and evacuation of the wounded.

A great deal can be learned from the ingenious improvisations and the ability to get the best use of material in the presence of scarcity. There are also interesting experiences with field surgery and evacuation of wounded in the subarctic cold. A detailed account is given of the various first aid and hospital units attached to various military groups, with description of the number and character of personnel, material needed, and the type of wounds treated in each unit. A number of illustrations and line drawings add much to the excellent description.

The other chapters consider the important problems of asepsis and anaesthesia in the battle zone, the management of traumatic shock, the use of blood transfusion, the

treatment of war wounds and infection in general, and the different regional wounds, as well as treatment of burns, electric injuries, frostbites, and others.

The book is written in Russian and consists of 300 pages. It is believed that its translation into English for the use of the English-speaking military surgeon would be of great use, provided a few minor changes are made. A comprehensive table of contents should be added, and a few parts of purely Russian interest should be omitted. Of course the translation and publication should not be delayed.

BLOOD GROUPING TECHNIC. A MANUAL FOR CLINICIANS, SEROLOGISTS, ANTHROPOLOGISTS, AND STUDENTS OF LEGAL AND MILITARY MEDICINE. Fritz Schiff, M.D., and William C. Boyd, Ph.D., with a foreword by Karl Landsteiner. New York, Interscience Publishers, Inc., 1942. $5.00.

The purpose of this book and the varied groups for whom it is of value are well expressed in the title. The book covers a large amount of material, much of which has not been available in the usual textbooks for the physician and laboratory worker.

An excellent theoretical discussion is given of the agglutinins and agglutinogens which are found in man and animals. The usual agglutinable factors (A, B, M, and N) as well as the more rare types (Rh, P, G, H, X, Q, and E) are considered. It is shown that 160 kinds of human blood are distinguishable serologically.

The material on blood-grouping, transfusion, and maintenance of blood banks is of practical importance for many. The laboratory methods seem to be given in unnecessary detail.

The section on the application of blood-grouping to legal medicine is of distinct value. The genetic approach is an aid to the laboratory worker. The technique for handling material other than blood—such as blood stains, urine, saliva, gastric juice, and other body fluids—to obtain the agglutinins is given.

The work on the blood groups in various animals is not only of interest to the anthropologist, but of practical value to the laboratory worker.

The section on the history of blood groups and the survey of the blood groups in different races is unique and of special interest.

The extensive bibliography on this large but little known field adds to the value of this book as a reference.

LA BIOPSIA POR ASPIRACIÓN EN EL DIAGNÓSTICO DE LAS LESIONES ÓSEAS (Aspiration Biopsy in Diagnosis of Osseous Lesions). José Valls, Carlos E. Ottolenghi, y Fritz Schajowicz. Buenos Aires, Libreria y Editorial "El Ateneo", 1942.

This book by the three authors is probably the only one considering the subject of aspiration biopsy in its complete up-to-date form. The paper, the type, and the numerous excellent roentgenographic and histological reproductions are of the highest quality, and add to the most interesting and well-balanced treatment of the subject. It is divided into three parts: general, special, and an original addition on biopsy by aspiration in the diagnosis of lesions of the vertebral bodies.

The general introductory part describes in detail the various methods and apparatus used by the authors and others; considers the advantages and disadvantages of the method in comparison with surgical biopsy; and gives the technique of aspiration and of the microscopic examination of the material obtained; and an instructive histopathological study of benign and malignant tumors.

The special part treats under separate headings the metastatic, primary malignant, and benign tumors, bone cyst, giant-cell tumors, hydatidosis, von Recklinghausen's disease, and the chronic specific and non-specific infectious diseases. Most of the discussions are accompanied by illustrative case histories with roentgenograms, smears, and histological reproductions.

The last part, concerning the aspiration diagnosis of the vertebral bodies, is based on original studies of the anatomy of approach. The authors find that the fourth, fifth,

sixth, and seventh cervical vertebrae can be safely approached by the lateral route. The thoracic spine can be approached only below the tenth vertebra. All the lumbar vertebrae can be examined. By the use of a simple apparatus and a biopsy needle, the authors have been able to reach a high degree of accuracy in establishing the diagnosis of involved vertebrae. Many roentgenograms, histological pictures, and a reproduction of photographs of gross pathological specimens illustrate this part of the text. There is a very good multilingual list of references at the end of the book.

SYNOPSIS OF PATHOLOGY. W. A. D. Anderson, M.A., M.D. St. Louis, The C. V. Mosby Co., 1942. $6.00.

The author has condensed in a small volume a very comprehensive coverage of the entire field of general pathology. The text is very fully illustrated and the publisher is to be commended for the excellence of the reproductions which add greatly to the clarity of the descriptions.

The chapter on Bone, Joints and Tendons shares with the other subjects discussed the favorable commendation which the entire work deserves. In this chapter there are three instances where it seems to the reviewer that the text is open to criticism.

1. In the discussion of Strümpel-Marie disease, there is not enough stress laid on the fact that the essential lesions differ from those of rheumatoid arthritis, with which it is compared, in that they are largely confined to the intervertebral and costovertebral ligaments, and, except for an occasional involvement of the hip and sacro-iliac joints and most infrequently of the shoulder joint, the pathology is confined to the spine.

2. In the section on osteo-arthritis one gets an impression that pain is not a conspicuous symptom. Though not so severe, and for this reason not so crippling, as rheumatoid arthritis, nevertheless, there may be a good deal of discomfort in Heberden's nodes, and in hip and knee-joint involvements.

3. There is still some difference of opinion in regard to the primacy of bone and joint tuberculous involvements. Some believe that the extension is from bone to joint, whereas other observers think the reverse is the rule. It is certainly true that the primary focus is most commonly in the lung, or certain of the glandular structures draining the upper air passages, or about the bronchial tree, and no physical examination of a patient suspected of having tuberculous lesions of the bones or joints can be regarded as complete unless careful search has been made for evidence of pulmonary or glandular invasion at some time, even though there may be no present reason to suspect their existence.

The book is an excellent compendium of general pathology.

ANAIS DO 4.º CONGRESSO BRASILEIRO DE ORTOPEDIA E TRAUMATOLOGIA 1940 (Annals of the Fourth Brazilian Congress of Orthopaedics and Traumatology). São Paulo, Sociedade Brasileira de Ortopedia e Traumatologia, 1942.

The "Annals" is a substantial book of over 500 pages, paper bound, and well published. Due to various circumstances it appeared after a delay of two years. However, it represents an excellent and complete report of the Fourth Brazilian Congress of Orthopaedics and Traumatology, edited by the Brazilian Society of Orthopaedics and Traumatology.

The book contains many original articles, reports, and observations by the Brazilian orthopaedic surgeons. The treatment of fractures of the spine occupies 174 pages and is represented by several articles. In "Treatment of Fractures of the Vertebral Column" by Dr. Renato Da Costa Bomfim, the author gives a comprehensive review of the entire subject with thirty-three case reports, many line drawings, roentgenograms, and photographs. In recent lesions the author is opposed to reduction by progressive traction, and advocates immediate reduction; he is also opposed to early laminectomies. Other articles on this subject are: "Treatment of Fractures of the Vertebral Column" by Dr. Bruno Maia; "A New Type of Table for Reduction of Fractures of the Spine" by Prof. Domingos

Define; "Fracture of the Vertebral Column" by Prof. Lelio Zeno; and "Teleradiography of the Spine" by Prof. Barros Lima.

The following is a list of other articles read before the Congress:

Autoplastic Articular Reconstruction of a Flail Elbow, by Dr. Achilles de Araujo,

The Social Function of Orthopaedic Surgery, by Prof. Barboza Vianna,

Oudard's Operation for Recurrent Dislocation of the Scapulohumeral Joint, by Dr. Alcino Coimbra,

A Case of Recurrent Dislocation of the Shoulders, by Dr. Rubem da Rocha Martins,

Radiotherapy of Scapulohumeral Periarthritis, by Dr. Achilles de Araujo and Dr. Carlos Osborne,

A New Stabilization Procedure for the Tibiotarsal Joint in Paralytic Feet, by Prof. Domingos Define,

Statistical Study of Club Feet, by Dr. Ivo Define Frasca,

Pterygium Colli Congenitum, by Dr. J. Rebelo Neto,

Serious Injuries of the Hand, by Prof. Lelio Zeno,

Fracture of the Medial Condyle of the Elbow Involving the Joint, by Dr. Mario de Abreu,

Operative Treatment of Fractures of the Ankle, by Dr. Orlando Pinto de Souza,

Original Apparatus for Suspension of the Hand, by Dr. M. Weinberger,

Parathyroidectomy in Engel-Recklinghausen Disease, by Dr. S. Hermeto Junior,

Lumbagos, by Dr. Silvio Marques,

Reflex Sciatic Pain in Disturbances of the Lumbar Region, by Dr. A. Steindler,

Delahaye's Arthrodesis in the Cure of Tuberculosis of the Knee, by Prof. Barros Lima,

Presentation of a Frame for Reduction of Fractures of the Upper Extremity, by Dr. Achilles de Araujo,

Agenesia Sacrococcygeal, by Dr. Bruno Valentin,

Plastic Surgery in the Correction of Deformed Hands, by Prof. Lelio Zeno,

Illustrative Case of the Value of Metalic Osteosynthesis in the Treatment of Medial Fractures of the Neck of the Femur, by Dr. Orlando Pinto de Souza,

Fractures of the Ankle, by Dr. Octavia Caputti and Dr. Oscar Rudge.

THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. H. Letheby Tidy, M.A., M.D.(Oxon.), F.R.C.P., and A. Rendle Short, M.D., B.S., B.Sc., F.R.C.S., Editors. Bristol, John Wright & Sons, Ltd., 1942.

This book is a summary of treatment obtained from a review of medical literature during the past year. The articles have been taken chiefly from American and British medical journals since many others, as the editors mention, are not available because of the war. A part of the printing was destroyed by bombs before the volume was completed. Despite these difficulties the editors have brought out a most creditable volume. The material is well arranged, with numerous illustrations and editorial comments. There is a comprehensive index. The section on orthopaedic surgery, under the able editorship of Prof. T. P. McMurray, is presented especially well. The discussions and editorial notes, while concise, are sufficiently full to give a clear picture of the treatment under discussion. As a year book of treatment it is a superior work.

SUBCUTANEOUS RUPTURE OF THE ILIOPSOAS MUSCLE. A REPORT ON THREE CASES. Gunnar Strandell. *Acta Chirurgica Scandinavica*, LXXXVI, 149, January 1942.

Ten cases from the literature and the writer's three new ones are the basis for a study of rupture of the iliopsoas muscle. In two cases there was a complicating lesion of the femoral nerve, and suppuration was not infrequent. Five of the thirteen patients died, but of the etiological condition and not of the iliopsoas rupture. Tetanus was responsi-

ble for the rupture in two cases. Other causes were lifting heavy weights, gymnastics, jumping, falling backward, and a fall with the legs abducted. The differential diagnosis between this entity and hernia of the obturator, coxitis, psoas abscess, and abdominal lesions must be considered. Operation is indicated to stop the bleeding, remove the clots, and prevent infection. If the hematoma is already infected, drainage should be instituted. Muscle suture is not satisfactory.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

Über intertrochantere Osteotomie statt subtrochanterer (Intertrochanteric Osteotomy Instead of Subtrochanteric). Nils Silfverskiöld. *Acta Chirurgica Scandinavica*, LXXXVI, 379, March 1942.

For sixteen years the writer has used the intertrochanteric or pertrochanteric osteotomy in preference to all others at the proximal end of the femur. The operation takes somewhat longer, but in many ways is preferable. There is less danger of splitting the bone of the trochanter than that of the shaft lower down. The cut surfaces are large and do not tend to displace. Fixation for four weeks is adequate for consolidation.

The operation is carried out on an orthopaedic table with bilateral extension. The greater trochanter is cut off with a chisel, and is reflected upward with the attached abductor muscles. Elevators are inserted just proximal to the lesser trochanter. A wedge of spongy bone is removed with the apex just proximal to the lesser trochanter. The leg is then abducted until the wedge is closed. When the hip is movable, it is necessary to hold the proximal fragment with a strong hook. The greater trochanter is then brought down and sutured in place. A bit of the aponeurosis of the vastus lateralis is left attached for this purpose. If it is desirable to increase the power in abduction, a piece of bone is laid under the greater trochanter in order to displace it laterally. A plaster cast is applied for four weeks.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

Chordoma in a Thoracic Vertebra. C. J. Hansson, *Acta Radiologica*, XXII, 598, 1941.

The author reports the case of a male, forty-five years old, admitted with complaints of hyperaesthesia at the level of the sixth and seventh thoracic segments. The patellar reflex on the left side was abnormal. The roentgenogram revealed destruction of the arch of the seventh thoracic vertebra. After excluding tuberculosis, a diagnosis of primary bone tumor was made and roentgenotherapy was instituted. Destruction of the vertebra was progressive, despite this treatment.

An exploratory operation was carried out through an incision which is not mentioned. "The arch and the posterior portion of the body of the seventh thoracic vertebra were found to be disintegrated. The cartilage between the seventh and eighth thoracic vertebra was transformed into a bluish tumor mass, which had penetrated into the vertebral body. The tumor tissue was curetted out and two tibial splints were fastened, one on each side of the spinous processes which had been laid free."

Microscopic examination revealed a chordoma. Two years after operation "slight paraesthesia and a spastic condition of the legs were still in evidence, but the pain had disappeared. There was no sign of a recurrence".—*Henry Milch, M.D., New York, N. Y.*

Experiences with Epidural Contrast Investigation of the Lumbo-Sacral Canal in Disc Prolapse (Perabrodil). Folke Knutsson. *Acta Radiologica*, XXII, 694, 1941.

Since 1940, when Lindblom first began investigation of the epidural space, some twenty cases have been studied. Perabrodil in 35-per-cent. solution is used as the contrast medium. After local anaesthesia with ten cubic centimeters of 1-per-cent. novocaine, twenty cubic centimeters of the contrast solution is quickly injected into the epidural space. Lateral, anteroposterior, and oblique roentgenograms are made in quick succession.

As a consequence of these studies, the author expresses the opinion that the method is valuable in the discovery of large disc prolapses. Small disc lesions, however, cannot be demonstrated by this procedure.—*Henry Milch, M.D., New York, N. Y.*

EINE ANATOMISCHE STUDIE ÜBER LUMBALE ZWISCHENWIRBELSCHEIBENPROTRUSIONEN UND ZWISCHENWIRBELSCHEIBENBRÜCHE IN DIE FORAMINA INTERVERTEBRALIA HINEIN (Anatomical Study of Protrusions of the Lumbar Intervertebral Disc and Ruptures of the Disc into the Intervertebral Foramina). K. Lindblom. *Acta Radiologica*, XXII, 711, 1941.

All who have had occasion to study the problem of disc protrusions have been impressed by the fact that in two apparently similar cases, one might show a typical disc protrusion, while in the other neither roentgenographic nor surgical substantiation could be found. In the latter type of case, Lindblom believes the protrusion is into the intervertebral foramina, rather than into the spinal canal. To resolve this problem, the vertebral columns of fifty-one cadavera, between the ages of nineteen and eighty-seven years (average age, fifty-five years), were examined. Of these only three, aged nineteen, thirty-eight, and forty-one years, respectively, were found normal. In the other forty-eight cases, some pathological appearance was found. In six cases, there was a constriction in the dura, corresponding to a disc protrusion. In none of the cases, however, was any hypertrophy of the ligamentum flavum found. In seven cases, the spinal nerves were found flattened in the intervertebral foramina. In all cases, one or more of the intervertebral discs showed evidence of degenerative phenomena and rupture. In the worst cases, all of the discs in a given spine were the sites of disease. In twelve cases there was definite protrusion of the disc into the intervertebral foramina.—*Henry Milch, M.D., New York, N. Y.*

THE OPERATIVE PROCEDURE IN INTERVERTEBRAL DISK PROTRUSIONS. H. Olivecrona. *Acta Radiologica*, XXII, 743, 1941.

During the past few years the author has abandoned bilateral laminectomy and transdural resection of protruded intervertebral discs. As a general rule hemilaminectomy and subdural removal of the disc has been possible. Even where this lesion is so large that bilateral laminectomy is necessary, the operation should be completed without opening the dura, if possible.

The author calls attention to the fact that protrusion of the nucleus pulposus should be carefully differentiated from protrusions of the annulus fibrosus. In the former case, an irregular, gritty surface is presented. In the latter, a firm, smooth bulge on the medial side of the corresponding nerve root is seen. No effort should be made to remove the protruded annulus fibrosus. On the contrary, the dura should be opened and the mass more carefully investigated. "If a protrusion of the annulus fibrosus is present, the bulge seen outside the dura will be recognized as a swelling situated immediately mesial to the dural opening, through which the root, usually the fourth or fifth lumbar, is emerging. The root is compressed either against the dural opening or more probably against the margin of the ligamentum flavum, forcing the posterior wall of the intervertebral foramen. As already pointed out, it is useless to try to remove the protruding part of the annulus fibrosus. Instead, the *sensory* root running over the protrusion is picked up in a small hook and divided or crushed with a silver clip."

The author states that this procedure has been performed, but the results are too recent to warrant the drawing of any conclusions.—*Henry Milch, M.D., New York, N. Y.*

ON MOVEMENTS OF FLUID INSIDE THE CEREBRO-SPINAL SPACE. Haakon Reitan. *Acta Radiologica*, XXII, 762, 1941.

During the course of myelographic studies, the author noted movements of the spinal fluid which appeared to be paradoxical with regard to respiration. On inspiration,

the column of contrast medium rose and became more slender, while on expiration the column sank and became thicker. In large part, the decrease in the diameter of the column seemed to be the cause of its elevation in the spinal canal. This phenomenon was noted in the erect position and to an even greater degree in the horizontal position. The amplitude of excursion of the contrast column was definitely increased when the intra-abdominal pressure was increased as in Valsalva's test.

The author attributes these effects to engorgement of the internal vertebral venous plexus. This causes a narrowing of the subdural space, a reduction in the diameter of the contrast column, and a consequent rise in the height of the column. He calls attention to the fact that, as a result of the central concentric displacement of the contrast medium, the column may lose contact with a protruding disc, and the characteristic deformity of the roentgenogram may disappear during inspiration.—*Henry Milch, M.D., New York, N. Y.*

COMPLICATING FACTORS IN THE TREATMENT OF INJURIES TO MENISCI OF THE KNEE JOINT. Clay Ray Murray. *The American Journal of Surgery*, LV, 262, February 1942.

This is a very excellent paper dealing mainly with some observations which in the past have been either overlooked or minimized. The first of these factors is the rapid and profound hypotonia and atrophy of the rectus femoris, the vastus intermedius, and the vastus lateralis which follow any kind of intra-articular damage to the bone. It comes on in a few days' time, and consequently is not due to disuse, but no explanation is offered. When an operation is performed, this feature is further intensified.

Since it has been shown that normal knee-joint stability is dependent mainly on musculature, and that the ligamentous apparatus is mainly a secondary check, it is desirable to rehabilitate the knee, whether conservatively or operatively, for maximum return of function of the muscles.

The author does not believe in repeated attempts at conservative treatment in recurrent meniscus lesions. He does, however, urge primary operation only when reduction of locking cannot be accomplished under anaesthesia. In other cases he aspirates the hemarthrosis if it is large enough to warrant it. Then a cast is applied snugly from foot to groin, and the patient is urged to walk as much as possible and to exercise the quadriceps muscle frequently. The cast is removed in one month, and the patient is urged to do more exercises on his own. If after such management recurrence occurs, operation is advised.

The second important factor is the incision. The author urges the parapatellar incision, because in only 30 per cent. of the cases is a clear-cut preoperative diagnosis of cartilage injury made; the small incisions are not adequate for dealing with other pathology.

The third important factor is the use of a tourniquet. He feels that, although a dry field is desirable, the anoxaemia of the extremity is no small matter in further interfering with muscle tone. He does not use a tourniquet, but places the patient in the Trendelenburg position, and by mosquito forceps, cautery, and careful control of bleeding before opening the synovial membrane, the joint work is done in a fairly dry field.

The author feels that muscle atrophy and loss of muscle tone following knee injuries is more extensive than is usually believed.—*T. J. Greteman, M.D., Iowa City, Iowa.*

SEUDOARTROSIS DEL ESCAFOIDES. TRATAMIENTO CON INJERTO ÓSEO (Non-Union of the Scaphoid. Treatment by Means of a Bone Graft). Oscar R. Maróttoli. *Anales de Cirugía*, VII, 321, 1941.

The author prefers the use of a bone graft in the treatment of ununited fractures of the scaphoid. He states that he has had consistently good success with this procedure,

and that excision is not indicated ordinarily. A case is presented in detail. The injury had occurred seven months before the patient was first seen by the author. Examination revealed tenderness in the middle of the anatomical snuff box, with a good deal of pain on motion, and disability. The roentgenogram showed an ununited fracture near the middle of the scaphoid. Operation produced an excellent result. The author lays considerable stress on certain points in the operative technique. An incision is made over the radial end of the scaphoid in order not to interfere with the circulation of the bone. After visualizing the end of the scaphoid, a hole of suitable size is drilled across the fracture site. A bone graft is then taken from the tibia and carefully prepared to fit the drill hole in the scaphoid. The bone graft is driven into place. Before cutting off the excess of the bone graft, the author takes a roentgenogram, using sterile precautions. The purpose of this is to make sure that the drill hole is in the right place, and that the graft has not extended beyond the bone and into the adjacent bone of the wrist, which might produce a fusion of this joint. The correct length of the bone graft is determined by means of the roentgenogram, and the excess is cut off. The author feels that the use of a bone graft in ununited fractures of the scaphoid is the best procedure, because it gets rid of the disability from the ununited fracture and at the same time does not produce additional disability by removing a bone which normally should be in the wrist.—*Louis W. Breck, M.D., El Paso, Texas.*

THE EXPERIENCE OF THE CANADIAN ARMY AND PENSIONS BOARD WITH AMPUTATIONS OF THE LOWER EXTREMITY. W. E. Gallie. *Annals of Surgery*, CXIII, 925, 1941.

This article is a presentation of the experience of Gallie, LeMesurier, Robertson, and Dale in the handling of 2,448 amputations of the lower extremity. These physicians have been in charge of the Pensions Military Hospital and the artificial limb factory connected with the Hospital since 1916.

It is stated that a good Syme amputation is the best amputation possible. In its favor are: (1) In the bedroom and bathroom the patient can walk on the stump without taking the trouble to put on his artificial limb; and (2) when fitted with a good artificial limb he can walk or run on his feet all day.

Against it is the unsightly ankle which makes it contra-indicated in the female.

In reviewing the unsatisfactory results from the Syme's operation, it was learned that the chief defects have been improper relationship of the weight-bearing heel pad to the bones of the leg; looseness of this pad, so that it wobbles about on the end of the stump when weight is applied; and pain resulting from irregular bone points, adherent scars, and neuromata.

The Syme operation has no application on the battle field or anywhere where there is risk of infection. The operation is not popular with limb makers because they have difficulty in fitting a limb properly.

In the discussion of amputations between the ankle and knee, the author has nothing favorable to say. In his experience most of the patients with these amputations have been reoperated upon many times, and have ended with above-the-knee amputations. These stumps will not stand up under the strain of a day's work because they are side-bearing stumps, and these areas are unaccustomed to weight-bearing and are not capable of it.

In above-the-knee amputations, the end-bearing stump produced by the Gritti-Stokes procedure is the one of choice. Any workingman with the need of an amputation above the level of a Syme amputation is subjected to a Gritti-Stokes procedure. In comparing this amputation with mid-thigh amputations, it is stated that an end-bearing stump gives a man a solid grip on the ground, and permits him to walk better. He is able to stand for long periods of time while bearing weight on the tough skin in front of the knee. Also, being equipped with a stump socket of the corset variety which does not reach the top of the thigh, he has much more freedom of hip movement.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

MINOR CAUSALGIA FOLLOWING INJURIES AND WOUNDS. John Homans. *Annals of Surgery*, CXIII, 932, 1941.

Major causalgia, well recognized as the symptom complex which follows injuries to certain great nerves, is mentioned. This paper, however, deals with minor causalgia which is excited not by trauma to large nerves and vessels, but by a great variety of lesser injuries, blows, crushes, fractures, thorns, and bites of animals. It also may accompany the inflammatory, obstructive form of thrombophlebitis, doubtless because the nerves surrounding the great vessels are caught in the inflammation. The changes in minor causalgia include atrophy of bone, disorders of joints, oedema, paraesthesia, and vasomotor dysfunction, which usually leave a cool, smooth, bluish skin, but occasionally cause vasodilatation. All these may appear together or in various combinations,—a sensory-sympathetic disorder which may even spill over to the motor side. The basic feature, pain, depends upon a very unstable reflex which must be broken up to obtain relief.

Livingston recommends procainization or excision of the source of pain,—the "trigger-point". Lehman uses periarterial sympathectomy. Smithwick is most radical, and employs the operation of sympathectomy. The author favors sympathetic block and repeats this as often as six times in some cases. If this fails, he resorts to sympathectomy. All these methods are effective. There is no especial indication for any one of them. It is stated, however, that periarterial sympathectomy is best adapted to well-localized causalgias,—for example, a radial operation for the thumb, an ulnar operation for the ulnar field.

Following relief, the patient should rest the limb for several months since additional trauma may cause a return of the symptoms.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

NEUROPATHIC ARTHROPATHY OF THE ANKLE JOINT RESULTING FROM COMPLETE SEVERANCE OF THE SCIATIC NERVE. Graham Kernwein and W. F. Lyon. *Annals of Surgery*, CXV, 267, February 1942.

This is a very complete and detailed account of a case of complete severance of the sciatic nerve with a six-centimeter defect, so that no attempt to repair the nerve was made. The patient had loss of motor and sensory function of all structures below the knee, but returned to work. Six months after his return to work sudden marked brawny induration of the extremity developed from a point below a constricting scar in the lower thigh. The ankle was in marked varus deformity. An amputation at the knee was performed because of the lymphoedema and paralysis. Roentgenographically, clinically, and microscopically the ankle joint was a typical neuropathic joint. The article contains excellent roentgenograms and photographs of the gross and microscopic specimens.

In the discussion the authors state that neuropathic joints develop in approximately 10 per cent. of all tabetic patients. They occur in 30 to 40 per cent. of patients with syringomyelia. Milgram doubts the existence of a neuropathic joint as a result of a peripheral nerve injury.

The theories of pathogenicity are three in number. The first contends that neuropathic joints develop as a result of injury to a nerve, and a low-grade spirochetal infection of the joint itself. There is no evidence for this. The second considers a disturbance in the nervous trophic regulatory mechanism as etiological. There is no evidence of special nerves whose function is merely trophic. In poliomyelitis marked trophic changes occur, but no neuropathic joints develop. The third theory is a mechanical one. It states that neuropathic joints are the result of trauma to a joint deprived of sensation.

The case presented supports this latter theory. The authors also believe that the mechanical theory holds true in neuropathic arthropathy from any cause.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

MALIGNANT TUMORS OF SYNOVIAL ORIGIN. Crenshaw D. Briggs. *Annals of Surgery*, CXV, 413, March 1942.

A brief summary of this subject reveals that malignancies arising from the joint capsule, bursal wall, or tendon sheaths, all stem from synovial tissue which is mesenchymal in origin. The synovial membrane may be divided into two parts histologically, an outer wall composed of dense connective tissue known as the fibrous layer, and an inner or synovial layer which is more cellular and is thought by many to secrete the viscid colorless fluid of the joint cavity. Each layer may give rise to a malignancy which differs histologically. Those arising from the outer layer are usually confused with the more common fibrosarcoma, and can only be distinguished from them by gross examination at time of operation. Those arising from the synovial layer are more cellular, and present papillary formations. The cells are epithelioid and cuboidal. The papillary formations have not been mentioned in previous papers on this subject. These formations reveal a central portion composed of a stroma of fairly typical fibroblasts, which is covered by a layer of cells of a more cuboidal type, with a large vesicular nucleus and acidophilic cytoplasm. The whole section is usually quite vascular. Mitotic figures are present, but not numerous.

These tumors appear between the third and fifth decades, present swelling as the initial symptom, and pain only occasionally. The duration of the symptoms is approximately two years. Clinically there is nothing very noteworthy about them, and more frequently than not they are diagnosed benign bursae or cysts. It is thus especially important to examine them microscopically.

A diagnosis of malignancy is made whenever a cystic tumor arising from a synovial structure microscopically shows papillary formation. This of course is contrasted both clinically and microscopically from villous arthritis.

Treatment consists of radical local resection whenever feasible,—when the tumor appears encapsulated. Wherever this cannot be performed without injury to important structures, amputation is indicated. Where excision has been employed, radiation should be used as an adjunct.

Prognosis is not so poor as the general literature would have us believe. Metastasis is late and to regional lymph nodes, and terminally to the lungs.

Nine cases are presented together with photomicrographs.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

SUBTALAR DISLOCATIONS. CASE REPORT OF THE INWARD TYPE. Robert A. Wise. *Annals of Surgery*, CXV, 445, March 1942.

Subtalar dislocations are interesting and unusual injuries. Baumgartner and Huginer collected all recorded cases up to 1907; Shands made an additional collection up to 1927; and the author has collected all cases (ten) since.

Four types are classified according to the position of the foot. The pathology and treatment of each is described.

The talotibial relationship is usually not disturbed. The navicular and calcaneum, together with the other tarsal bones, are displaced.

In the *inward* type the head of the talus is completely separated from the navicular and lies at the lateral side of the foot on the superior surface of the cuboid. The extensor tendons are medial to the head of the talus, and the cruciate crural ligament lies beneath it. The calcaneum is displaced inward. Ligamentous damage is extensive with rupture of the dorsal talonavicular, the interosseous talocalcaneal, the anterior and lateral talocalcaneal, and the anterior talofibular ligaments. Rupture of the powerful interosseous talocalcaneal ligament is essential to the production of the dislocation.

In the *outward* type, the head of the talus lies on the medial side of the foot in relation to the inner surface of the navicular, while the calcaneum is displaced outward.

In the *backward* type, the calcaneum is displaced backward and the head of the talus rests upon the superior surface of the navicular.

In the *forward* type, the calcaneum is displaced forward and the head of the talus rests upon its superior surface.

Treatment in early simple cases consists in closed reduction under anaesthesia, with the knee flexed to relax the tendo achillis. Traction is made in the long axis, and the foot is returned to its normal position while an assistant puts pressure over the head of the astragalus. Dorsiflexion of the foot helps relax the tibialis posterior tendon, and is useful in the reduction of the outward and inward types. In the backward type, extreme plantar flexion is helpful in obtaining reduction. Most cases of forward dislocation require open reduction.

Arthrotomy is required when closed reduction fails. Late, unreduced cases require open reduction and arthrodesis of the involved joints.

A case of inward dislocation is presented, together with an account of the treatment by closed reduction. Photographs and roentgenograms accompany the presentation.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

Recent Advances in the Diagnosis and Treatment of Ruptured Intervertebral Disks. Walter E. Dandy. *Annals of Surgery*, CXV, 514, April 1942.

This paper states that the diagnosis of ruptured intervertebral disc can be made almost 100 per cent. of the time. There are several reasons for this. In the first place the history is characteristic. There is low-back pain which spreads down the posterior aspect of one or, at times, both legs, and is intensified by coughing or sneezing. The pain recurs with more or less free intervals between attacks. In examination one item only is of importance, — namely, the reduction or loss of the Achilles reflex on the affected side. The author deprecates the use of contrast media in the spinal canal. Love and Spurling have statistical studies which show that 96 per cent. of all ruptured intervertebral discs are situated at the fourth and fifth lumbar vertebrae.

The syndrome caused by a "concealed disc", identical with that described above, represents 25 per cent. of all disc lesions. A concealed disc is one that protrudes so slightly that it could hardly be found at operation unless one explored the subdural region with great care. Always there is a very tiny bulge of the intervertebral space, with thickening of the spinal ligament; it indents with pressure of the forceps, and gives a sense of fluctuation upon pressure by them. When incised, the forceps dip deeply into the cavity of the disc. At times it is laterally placed, at other times at or near the midline. In every case the emerging nerve has been adherent to it. The interior of the disc must be opened. It is not necessary or possible to remove the contents completely to produce a cure, but it is necessary to open the disc as widely as possible, so that the non-viable content—that is, the sequestrum—may be extruded. From April 1, 1941, to December 10, 1941, the author diagnosed correctly sixty-three cases without the use of contrast media.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

Roentgenologic Changes in the Bones in Cases of Pseudohypertrophic Muscular Dystrophy. Bernard S. Epstein and Joseph L. Abramson. *Archives of Neurology and Psychiatry*, XLVI, 868, 1941.

The authors question the current concept that this disease is one which affects the muscular system primarily, and present seven cases of progressive muscular dystrophy in which roentgenographic changes were demonstrable. The most common changes were symmetrical diminution in the size of the scapulae, rather large humeral heads in relation to the small, shallow glenoid fossae, slender humeral shafts with widened medullary canals, and thin but not atrophic cortices. In all the patients the pelves were small, with flaring iliac bones, prominent ischial spines, and marked coxa valga. These pelvic changes, aside from the coxa valga, may be accounted for by the fact that the patients had spent many years in wheel chairs.

The authors doubt that the osseous changes result from disuse. The usual changes

associated with disuse are rarefaction and decalcification, particularly in the articular ends, but in the authors' series these changes did not occur; atrophy of disuse is progressive, but their studies showed no progressive loss of density of the bone over a period of years.

They conclude that the older view—that muscular dystrophy is a disease which involves muscle only—may have to be revised to include the concept of a more generalized pathological process. In addition to the alterations in creatinine metabolism and the possible disturbance in the endocrine glands, there is involvement of bone. It is their opinion that the changes in bone cannot be explained on the basis of disuse alone, but may be an expression of a mesodermal defect resulting in muscular and skeletal defects.—*V. Wolkin, M.D., Iowa City, Iowa.*

HAEMANGIOMA OF THE HAND, INVOLVING PHALANGEAL BONES, WITH DISTINCTIVE RADIOLOGICAL APPEARANCE. Konrad Hirschfeld. *The Australian and New Zealand Journal of Surgery*, XI, 136, 1941.

A man, twenty-four years old, complained of pain and swelling of his left hand, and index and middle fingers, of fifteen years' duration. There was a soft, elastic swelling, a globular mass, between the second and third metacarpal heads. The swelling and pain increased when the hand was held in the dependent position. Roentgenograms revealed abnormal separation of the second and third metacarpal heads, and slight thickening of the periosteum of the metacarpals with some areas of rarefaction in the cortex. The proximal phalanx of the index finger showed a central area of honeycombed rarefaction. The treatment consisted of the injection of fifteen cubic centimeters of 5-percent. solution of sodium morrhuate into various parts of the swelling. A severe reaction followed immediately, but the end result was excellent.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

SURGICAL EXPERIENCES IN THE MIDDLE EAST. Julian Smith. *The Australian and New Zealand Journal of Surgery*, XI, 153, 1942.

This is an account of the author's experience with a surgical team of the Australian army in the western desert of Africa during the early months of 1941, and of subsequent work in a casualty clearing station in Syria. This work was done under difficult desert conditions where it was practically impossible to exclude dust from the operating theater; where water had to be brought from a distance of ten miles; and where electric light from portable generators was available only at times, while at other times surgery had to be performed with the aid of lamps and torches.

A small field autoclave was used for instruments, linens, gauze, and dressings. Gown and gloves were worn only for abdominal and head operations. Ether was the most frequently used anaesthesia and was preferred, although pentothal sodium used intravenously was found to be excellent for short operations. A blood bank was established on the day before a battle by taking blood from Group 2 and Group 4 donors selected from minor casualties. The blood was kept in the ice-box for a period not exceeding three days. In the author's opinion, transfusion is the only ideal means of resuscitation of a severely injured patient, and plasma is useful only in tiding a patient over a critical period until the proper restorative measures can be instituted.

In discussing the general treatment of wounds, the author recommends that the débridement include a thorough exploration with a wide incision in the deep structures. If, however, a wound is not seen until it is infected, the surgeon should content himself with providing drainage. The local and oral administration of sulfanilamide is routine, and the author is convinced of its value, having observed only seven cases of gas gangrene out of 1500 casualties, and in these infection was present when the patients arrived at the casualty clearing station. The use of a tight vaseline pack is condemned, since it will prevent free drainage. A plaster cast is employed in all compound fractures and in large muscle wounds.

Abdominal wounds require early operation. After the abdominal cavity is cleaned of blood and debris, small perforations are searched for and closed with a simple Z, purse-string suture of linen. Larger perforations frequently require anastomosis. The convalescence is stormy, and the prognosis is poor. Nine of the author's patients recovered out of nineteen who were operated upon.

Chest wounds have a surprisingly low mortality, and are not as urgent as abdominal injuries. Sucking wounds of the chest, however, demand immediate treatment; a few sutures of silk worm are placed deeply and tied firmly to close the opening. The treatment of other chest conditions in forward operating rooms is conservative.

For compound fractures of the femur, the thigh wound is opened widely, and a five-inch incision is made in the fascia lata to expose the fracture. Foreign bodies, loose bone, and devitalized tissue are removed. After hemostasis is secured, the wound is irrigated with hot saline, swabbed with acriflavine, and dried. Sulfanilamide powder is introduced, and a large blob of vaseline is placed on the wound, which is then covered with a flat gauze dressing. A Kirschner wire is introduced through the upper tibia, and the extremity is placed in traction in a Thomas splint with the knee flexed at 30 degrees.

Treatment of compound fractures of the humerus must be modified, because a patient cannot go into an ambulance with his arm widely abducted. Most of the author's patients are placed in a plaster slab applied to the postero-external surface of the extremity, extending from the vertebral border of the scapula to the metacarpal heads. The arm is held in slight abduction with traction applied by an assistant, and the elbow is flexed to 90 degrees. The plaster slab is held in place by a few turns of plaster bandage, and the extremity is fixed to the trunk by a few additional bandages, slight abduction of the arm being maintained.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

BASE HOSPITAL MANAGEMENT OF SOFT TISSUE INJURIES. B. K. Rank. *The Austra'ian and New Zealand Journal of Surgery*, XI, 171, 1942.

This is an account of treatment of soft-tissue injuries by a faciomaxillary and plastic-surgery unit of an Australian general hospital. The author concedes the value of débridement and closed plaster in the early emergency treatment of larger wounds, but has found that continuation of this type of "passive" treatment for wounds with large skin losses and varying degrees of infection results in slow healing, with scars poor in texture and often unstable. Smaller wounds are usually excised in the forward operating theaters and allowed to heal spontaneously, with the common sequela of secondary infection and indolent "chronic wounds". These chronic wounds represent failure, as indicated by a retarding or arrest of normal secondary-intention healing, and by showing indurated, raised, and keloidial edges stopping abruptly at the granulating area, with no sign of the thin actively growing blue edge of a healthy wound. There is an undue amount of deep fibrosis which fixes the scar to the surrounding tissues, and gives rise to undue functional disability. The most important cause of these chronic wounds is infection with streptococcus pyogenes, which inhibits epithelial proliferation by a special histolytic property.

All wounds are cultured for streptococcus, and roentgenograms are made for foreign bodies. The patient's general condition is built up by proper diet, vitamins, and transfusion as indicated. Transfusion has been found necessary in practically all cases where the raw area is larger than six inches by six inches. After a careful preparatory routine, the raw areas are covered with skin grafts. The preparatory routine is designed to cleanse the wound of slough and debris, eliminate streptococci and other surface bacteria, reduce the granulating area to a firm regular base, and by massage and exercises to improve the function of the part. A daily bath in 2-per-cent. saline at 90 degrees is given for periods of one-half hour, increasing to three or four hours according to the patient's tolerance. Daily dressings are done after the bath, with rigid sterile technique. If streptococcus is present, all sloughs are removed and the wound is sprayed with sulfanilamide powder; a vaseline-gauze dressing containing one per cent. of balsam

of Peru is applied, over which moist saline packs are placed. If no streptococci are present, sulfanilamide is not employed; instead, wet packs of eusol are used. This preparatory routine is carried out until the wound appears clean and healthy with firm granulations.

Before the skin-graft operation, sulfanilamide is given by mouth for three days, and is continued after the operation; no sulfanilamide is given on the day of the operation. Grafting is performed by the pinch or razor method. Sulfanilamide powder is applied to the raw area before razor grafting and on top of pinch grafts. A dressing of the vaseline gauze with balsam of Peru is sutured to the skin edges and this is covered with a molded pack of paraffin and flavine wool for compression. An elastic bandage is then applied. The first postoperative dressing is done five days later, and the second, after two or three more days. Dressings are then done daily and the bath routine is resumed for patients with pinch grafts. If streptococcus infection has been present previously, the local use of sulfanilamide is continued.

The author's series consists of fifty skin grafts, of which twenty-five were done by the razor method. In 80 per cent. of the cases there was a satisfactory take. These good results are attributed particularly to the meticulous preparatory routine.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

PRELIMINARY REPORT ON INTERNAL DERANGEMENTS OF THE KNEE JOINT TREATED AT AN AUSTRALIAN GENERAL HOSPITAL, AUSTRALIAN IMPERIAL FORCE ABROAD, TO MAY 31, 1941. R. V. Graham. *The Australian and New Zealand Journal of Surgery*, XI, 185, 1942.

The author presents a series of 128 knee operations performed in an area which had been previously considered unsafe for operations during the summer months, because of the excessive dust and heat. Most of the patients gave a history of previous knee derangements, the commonest cause being injury during football. The most frequent symptom described was "giving way" or a sense of insecurity of the knee. True locking was noted in only forty-two cases. On examination only two patients were seen while the knee was locked. Limitation of flexion was observed in seven cases and of both flexion and extension in eight cases. Undue anteroposterior mobility was present in twenty cases. Local tenderness was elicited in fifty-five cases. Effusion was found in forty-one knees. In nineteen instances, a click could be elicited when the flexed knee, while held with the leg abducted and externally rotated, was brought into extension. In a few cases of tears of the medial meniscus, there was local swelling over the involved meniscus, while similar localized swelling was present in every instance of cyst of the external meniscus. Roentgenograms were not of value in any case of derangement of the medial meniscus. Two knees, in which osteochondritis was found at operation, showed no roentgenographic findings. In two cysts of the lateral meniscus, the films showed flattening of the lateral condyle of the tibia with a small spur on the lateral articular margin of the tibia.

Spinal anaesthesia was used. Hemostasis was obtained by means of a sterile tourniquet made from an old inner tube. Arthrotomies were performed through a parapatellar incision one and one-half inches long. As much of the meniscus as possible was dissected out. In the early cases of the series, the skin was closed with catgut, and a compression bandage was applied. It was found, however, that many of the skin wounds broke down, apparently as a result of excessive perspiration of the skin. Subsequently the skin has been closed with interrupted silk sutures and no compression bandage has been used. A small flat dressing is placed on the skin wound for seventy-two hours. The dressing is then removed and the wound is painted with compound tincture of benzoin. Early active use of the quadriceps is insisted upon, active exercises are started in forty-eight hours, and the patient is allowed to walk after seventy-two hours. No crutches or canes are allowed, and the patient must walk without a limp. The author has found that postoperative effusion disappears with active use.

The average hospital stay in this series of cases was forty-two and one-half days, after which the patients were returned to light duty. Full duty was resumed after an average of seventy-five days. Of the 128 cases in this series, 104 are now on full duty.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

ANKYLOSIS OF THE JAW: CARTILAGE GRAFT RESTORATIONS OF THE JOINT: A NEW OPERATION. H. P. Pickerill. *The Australian and New Zealand Journal of Surgery*, XI, 197, 1942.

Previous operations employed in cases of ankylosis of the jaw include Esmarch's resection of a wedge of bone from the angle of the jaw, and arthroplasty procedures. The author objects to Esmarch's operation because it does not attack the seat of the pathology, it robs the patient of the use of important muscles of mastication, and interferes with the growth of the mandible. Maintenance of the space between the bone ends is difficult, occlusion is disturbed, and the mandibular artery, vein, and nerve are divided. Arthroplasty is not satisfactory because, in addition to being a difficult technical procedure, it produces only a pure hinged joint with no lateral movement, and there remains an unnatural stiffness of mandibular motions, the jaw coming to a sudden stop when the mouth is opened.

The following new operation is advocated. A Z-shaped incision is made over the temporomandibular joint. The neck of the condyle is exposed, stripped, and divided with a Gigli saw. Two pieces of rib cartilage one inch long are shaped, one to fit the glenoid fossa and one to fit the neck of the condyle, and these are then sutured in place with silk.

The author claims the following advantages for his operation. It interposes in amount and character a tissue very "like" that removed. The anatomical arrangements for mastication are restored. Rib cartilage adheres very quickly to surrounding tissue. The author further states that his procedure has resulted in free and natural movements of the jaw including lateral motion.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

FRACTURA DE BENNET (Bennett's Fracture). Héctor Ordóñez Ferreyra y Héctor Martinez Carranza. *Boletines y Trabajos de la Sociedad de Cirugía de Córdoba*, II, 263, 1941.

This paper discusses Bennett's fracture in general, and analyzes eight cases of the authors. In a review of the literature, they state that Bennett first described this fracture in 1880 and that since then all fractures of the proximal end of the first metacarpal have been called Bennett's fracture. It is possible to subdivide these fractures according to the type of fragmentation and the obliquity of the fracture, and the authors give the detailed classification of Kuss. The authors' cases were treated by means of traction. Skeletal traction with a small wire was used in five cases, and adhesive-tape traction in the other three. In a general discussion of the subject, the authors point out the ease with which the deformity recurs if it is given the opportunity. They state that, because of the importance of the joint of the proximal end of the first metacarpal, a malunited fracture will give 15 to 20 per cent. permanent disability of the hand. This joint is involved in all motions of the thumb and especially in opposition. The authors go into the various movements of the hand in great detail in order to emphasize the importance of securing a good reduction in this type of fracture. The various anatomical and physiological considerations involved in applying traction to this fracture are discussed. There are many ways of making the traction, and each is presented, with its advantages and disadvantages. The disadvantage of using adhesive tape is that the tape may become loosened in the course of time. They conclude that traction by means of wire is in general the best, and describe in detail their exact method of applying it. All of their eight patients made a satisfactory recovery, and the authors are convinced that

traction is necessary in all cases of Bennett's fracture. The paper is scientifically prepared and well presented, and is an excellent treatise on the subject of this important fracture of the hand.—*Louis W. Breck, M.D., El Paso, Texas.*

ENFERMEDAD DE HOFFA (Hyperplasia of the Retropatellar Fat). Vicente J. Bértola y Dante J. Baistrocchi. *Boletines y Trabajos de la Sociedad de Cirugía de Córdoba*, II, 313, 1941.

A case of marked hyperplasia of the fatty tissue below the patella and behind the patellar ligament is presented. This condition was first described by Hoffa in 1904, and is frequently called Hoffa's disease. The patient was an Italian woman, sixty years old, who had had an injury to the knee four years previously. The knee was not painful. There was a mass the size of a small orange, which felt lobulated below and medial to the patella. There was slight tenderness on palpation and a very fine crepitation. There was very little limp, but a slight amount of pain was produced on forced extension. The roentgenograms showed a slight amount of bone atrophy, and the tumor mass was definitely distinguishable, in both the anteroposterior and lateral views, as a soft-tissue tumor. Pneumo-arthrogram (roentgenogram after air injection of the joint) showed the mass to be not connected with the joint. The serology for syphilis was negative, and the general examination of the patient revealed nothing of importance. On the basis of the foregoing history, examination, roentgenograms, and laboratory findings a preoperative diagnosis of Hoffa's disease was made. Under local anaesthesia, and employing a large U-shaped incision, the fatty tumor mass was excised. It was sixteen centimeters in diameter, lobulated, and fairly discretely defined. It was adherent to the periosteum of the tibia in one area. The capsule of the joint was so distended that it was hard to define in places, and in general the dissection was rather difficult. The article is well illustrated with roentgenographic reproductions, drawings, and photographs.—*Louis W. Breck, M.D., El Paso, Texas.*

CAISSON DISEASE (COMPRESSED-AIR ILLNESS) OF BONE WITH A REPORT OF A CASE. Valentine A. J. Swain. *The British Journal of Surgery*, XXIX, 365, April 1942.

Caisson disease is the result of injuries to tissues by liberated bubbles of nitrogen, when the body is too rapidly decompressed.

A patient of thirty-seven years, a general laborer, complained of pain in both shoulders and in the right hip. He had been employed in underground work until sixteen months before admission, and for four years before that he had worked in compressed air.

Roentgenographic examination showed a marked avascular necrosis of the articular surface of the head of the right humerus, with similar but lesser changes in the left. Two months later he died of coronary thrombosis. At autopsy, the appearance of the humeral heads was that of aseptic necrosis of the bone, compatible with a sudden vascular occlusion at a previous date.

The writer states that in caisson disease the lesions of bones are infarcts, which are produced by nitrogen emboli. These lesions are usually found in the long bones and are usually multiple. He states that it is quite possible that many more of these late lesions will be seen in "those who work in the bowels of the earth, soar to great heights, or descend into the depths of the sea".—*Ernest M. Daland, M.D., Boston, Massachusetts.*

TUBERCULOSIS OF THE SPINE: OBSERVATIONS ON LOCALIZATION, EXTENSION AND HEALING—THEIR BEARING ON DIAGNOSIS AND TREATMENT. J. V. de los Santos. *The Bulletin of the Quezon Institute*, I, 283, 1941.

The author has published a very interesting article on "Tuberculosis of the Spine". His excellent "Summary and Conclusions" are quoted as follows:

"The present study is based upon 74 clinical cases of tuberculosis of the spine

examined roentgenologically. Twenty-one of these cases came to necropsy and the spines were studied both roentgenologically and pathologically in an attempt to determine the localization, extension and healing of the tuberculous spinal infection.

"The intervertebral articular type of the spinal localization has been found roentgenologically and pathologically to be the most common. The incidence is greatly increased by the rather large number of cases with posterior juxta-articular localization, which generally fails to show roentgenologically until late in the disease after marked structural changes have already taken place. The central type of localization comes next in frequency.

"The tuberculous infection may find lodgement in a number of distant vertebral bodies. As high as 40 per cent. of the cases pathologically studied showed multiple vertebral localization.

"The spinal infection appears to follow no definite course or pattern and its extension depends to a great extent upon its initial localization. While its common course is towards the spinal canal and laterally, yet in a few instances it pursues its way along the anterior and posterior spinal ligaments with secondary involvement of the vertebra and the intervertebral discs. Although the intervertebral discs in adults appear vulnerable to the infection, in children in most instances the discs are quite resistant to it and escape involvement in spite of destruction and even collapse of adjacent vertebral bodies.

"During the extension of the infection sequestra of various sizes are commonly formed but they remain generally unrecognizable in the roentgenogram.

"Fine and early sequestra are frequently made up of bone plates or ossified epiphyses following invasion by tuberculous granulation tissue. A primary epiphyseal involvement, however, has not been seen so far either from the microscopic examination or in the roentgenogram taken of a slice of the bone. The sequestra are commonly found on the anterior and posterior edges of the vertebra and are detected only upon roentgenological examination of a thin slice of the bone and upon microscopic study.

"Bilateral (kissing) sequestra are at times encountered in spite of the presence of intact intervertebral discs. Contrary to König's theory of embolism, their formation appears to result from secondary invasion of the bone by granulation tissue, as has also been mentioned previously by Phemister.

"Aside from the common subjective and objective symptoms, roentgenological manifestations of spinal caries are important in establishing the diagnosis. The recognition is based upon the appearance of bone changes—usually in the nature of defects— in the various regions of the vertebra, which form the frequent sites of localization of the tuberculous infection; namely: intervertebral or juxta-articular, central and anterior.

"The presence of abscess shadow about the lesion is an important finding but is not essential in the diagnosis. The same holds true with the angular deformity or gibbus of the spine.

"Osteoperiostitis along the regions of the anterior and lateral spinal ligaments as well as new bone formation on or about the small intervertebral articulations, spinous ligaments and ligamenta flava in arrested and healing tuberculous lesions is a significant finding.

"Repair of the spinal lesion is usually effected by fibrous tissue replacement. In some instances, however, osseous repair takes place, but the amount of bone replacement, as a rule, is meagre and incomplete.

"The healing of the lesion is usually accompanied by the formation of new bone on or about the vertebral bodies and the small intervertebral joints; and likewise by ossification of the spinous ligaments and ligamenta flava included in the diseased segment of the spine, notwithstanding the absence of secondary infection.

"The new bone formation, which in some instances has been found to be pronounced about the spinal lesion and the posterior arch, serves, to a certain degree, as a guide in the selection of any surgical attempt at stabilization by internal fixation of the diseased portion of the spine. In the event it is found advancing and marked, internal fixation may be unnecessary and at times even harmful to the repair processes."

CALCIUM, PHOSPHORUS, NITROGEN AND MAGNESIUM METABOLISM IN NORMAL YOUNG CHINESE ADULTS. H. I. Chu, S. H. Siu, H. C. Hsu, H. C. Chao, and S. H. Chew. *The Chinese Medical Journal*, LIX, 1, 1941.

This study was made on normal Chinese adults of both sexes, to determine the calcium, phosphorus, nitrogen, and magnesium metabolism, and the effect of therapeutic doses of vitamin D. The conclusions are:

The average calcaemia of the male group was 10.29, and of the female group, 9.86. Neither individually nor as a group was there any difference between the serum calcium levels before and after the administration of vitamin D.

The serum inorganic phosphorus has an average value of 3.99 milligrams per 100 cubic centimeters. There is a small difference between the two sex groups, the value being higher in the female. Vitamin D did not produce any changes in the serum inorganic phosphorus.

The serum phosphatase averaged 1.68 units per 100 cubic centimeters, and was a little higher in the females.

The serum magnesium average was 2.75 per 100 cubic centimeters.

The average maintenance of calcium requirement for an adult Chinese was calculated about 7.3 milligrams per kilogram per day. The phosphorus maintenance requirement needs an intake of 13.6 milligrams per day. Magnesium maintenance was about 5.5 milligrams per kilogram per day.

The paths of excretion are as follows:

Calcium. The male group excreted more calcium (25 per cent.) in urine than the female group (15 per cent.). Administration of vitamin D seemed to be followed by an increase of urinary calcium excretion. It is possible that vitamin D, while incapable of promoting calcium retention in normal persons, tends to alter the path of calcium elimination in favor of the urinary tract.

Phosphorus. The average urinary excretion is 60 per cent. of the total excretion. No difference between male and female was found, or any variation after the administration of vitamin D.

Magnesium. The urine magnesium represents 29 per cent. of the total magnesium output. No difference between the sexes was found, and no variation after the administration of vitamin D.—*José Puig, M.D., Iowa City, Iowa.*

SERIOUS COMPLICATIONS OF RUPTURED INTERVERTEBRAL DISKS. Walter E. Dandy. *The Journal of the American Medical Association*, CXIX, 474, June 6, 1942.

The author presents three quite interesting cases of serious complications following ruptured discs,—one in the cervical region, which resulted in necrosis of the cord and death; one in the thoracic region, with paraplegia partially relieved by operation; and one in the lumbar region, with permanent sensory loss and incontinence. These cases, together with two others previously reported and one not reported, comprise a total of six cases of serious complications out of a total number of 300 patients operated upon.

The author stresses the importance of early diagnosis and operation for rupture of the cervical and thoracic discs before permanent damage results, and it is in these cases only that he feels the use of iodized oil is indicated.—*Brandon Carrell, M.D., Dallas, Texas.*

LUMBAR PUNCTURE. ITS POTENTIAL ROLE IN THE PRODUCTION OF INJURIES TO THE INTERVERTEBRAL DISK. Donald Munro and Warren G. Harding, 2d. *The Journal of the American Medical Association*, CXIX, 482, June 6, 1942.

The authors demonstrate that perforating injury to the posterior part of the annulus fibrosus is a distinct possibility during the course of lumbar puncture, and advise that this procedure be performed cautiously and with the spine extended rather than flexed. The conclusions were warranted by lateral roentgenograms taken during the course of myelography by a two-needle technique. It was demonstrated that 36 per cent. of the needles

were in a position which would have penetrated the annulus fibrosus if they had been inserted farther in the line of their course. The distance between the point of the needle and the surface of the annulus averaged between four and five millimeters. The findings also indicated that the interspace between the fifth lumbar and first sacral vertebrae is safest, and that the third and fourth interspaces should be avoided if possible.—*Brandon Carrell, M.D., Dallas, Texas.*

A Simple Skeletonized Plaster Splint for the Cervical Spine. Sam W. Banks, Edward L. Compere, and Charles Watson. *The Journal of the American Medical Association*, CXIX, 631, June 20, 1942.

This article describes a simple way of making a light-weight plaster splint, instead of a metal brace, for use in the treatment of a fractured cervical spine. The splint is light and resembles the type of metal brace widely used. Its advantages of course are that the total cost of materials does not exceed four dollars.—*Clyde B. Trees, M.D., Dallas, Texas.*

The Development of Sarcoma in Myositis Ossificans. Report of Three Cases. George T. Pack and Ralph R. Braund. *The Journal of the American Medical Association*, CXIX, 776, July 4, 1942.

Following a description of myositis ossificans and a short synopsis of the cases that have been reported, the authors present a short classification of the different types and manifestations of the disease.

In a review of the literature, five cases were found in which the bony tissue of myositis ossificans underwent malignant neoplastic change. Two new cases are added to these, complete with case histories, physical findings, and roentgenograms and photographs. A third case of myositis ossificans progressiva was associated with malignant tumor, probably myxoliposarcoma.—*H. H. Beckering, M.D., Dallas, Texas.*

The Principles of Fracture Treatment. A. T. Andreasen. *Journal of the Indian Medical Association*, XI, 158, March 1942.

The author discusses the modern principles of fracture treatment as logical outgrowths of the pioneer orthopaedic work of Hugh Owen Thomas and Robert Jones. He describes the histological, biochemical, and pathological aspects of bone repair, and the relation between vascularity and the rate of repair. The basic law of fracture treatment is that every fracture must be completely immobilized in anatomical alignment without interruption until the fragments are firmly united. The immobilized part, encased in plaster, should be actively used throughout the period of healing to prevent muscle atrophy and joint adhesions. This technique gives better results than massage and passive movement.—*Robert M. Green, M.D., Boston, Massachusetts.*

A Sequel of Knee Ligament Strain: Pellegrini-Stieda's Disease (Metacondylar Traumatic Osteoma). W. R. Hamsa. *Nebraska State Medical Journal*, XXVII, 62, February 1942.

The characteristic feature of this condition is the presence of an area of new bone or calcific change in the region of the medial femoral condyle, presumably the femoral end of the medial collateral ligament. The condition develops following direct or indirect trauma, and is most common in active adults. The earliest symptoms are those of synovitis—pain and swelling—followed by some improvement but not complete recovery. Limitation of motion may occur gradually and become progressive. Tenderness is localized over the medial aspect of the medial femoral condyle. Gradual enlargement of this condyle, either bony or calcific, may or may not be the cause of the disability. Joint

relaxation and injury to semilunar cartilage may contribute greatly to the disability. The process seems similar to myositis ossificans.

Treatment consists of (1) immobilization in a splint or cast to remove all stimuli which may increase bone formation; and (2) deep heat, preferably diathermy, to facilitate absorption. Surgical removal is seldom necessary as the enlargement is rarely sufficient to give rise to a mechanical disorder.

The rapidity with which an area of increased density within the area of ligament attachment may appear on roentgenograms following injury is not appreciated, and for this reason alone this case report is justified.

A plasterer, thirty-nine years old, complained of pain and disability of left knee following a fall which turned the left leg into marked valgus and produced severe pain. On attempting to walk he felt a snap in the knee which became freely moveable but developed moderate swelling. Five days following injury, the roentgenogram showed no bone change; but eighteen days following injury, it showed calcification above and medial to the medial femoral condyle, and was interpreted as an old injury. Three months after the injury, a tender palpable hard mass appeared over the medial femoral condyle, and the roentgenogram showed the fairly smooth outline of the calcifying area proximal to the medial condyle of the femur. This case illustrates one of the earliest appearances on record.

Surgical removal in the majority of reported cases has been followed by recurrence of the bony mass. Surgery would seem to be indicated only after improvement by conservative means has ceased and after the bony mass has shown definite condensation and smooth outline.—*J. Y. Sher, M.D., Iowa City, Iowa.*

COLLES'S FRACTURE. William Darrach. *The New England Journal of Medicine*, CCXXVI, 594, April 9, 1942.

The author describes the anatomy, pathology, symptoms, signs, and treatment of Colles's fracture. He prefers, in the treatment, the use of the "sugar-tong"—single plaster splint—which he generally replaces seven to ten days later, after the subsidence of the swelling, with a circular plaster gauntlet from the mid-palm to the upper forearm. The sugar-tong splint is applied so as to allow free motion of the interphalangeal and metacarpophalangeal joints, and finger movement is encouraged.

When the plane of fracture is oblique, or when there is comminution of the dorsal surface, there is a strong tendency, because of the muscle pull, for the dorsal shift and tilt to recur. This can be partially overcome if the splint is applied with the wrist in strong flexion and moderate adduction.

If the comminution is so extensive that no form of splint alone prevents collapse and shortening, he advises using double Kirschner wire and plaster, one wire through the bases of the second, third, and fourth metacarpals and the other higher in the forearm in the upper ulna, just distal to the coronoid. Reduction is obtained by traction on the wires, and a cast is applied incorporating the two wires. These are left in place for from five to seven weeks.

He describes the late disabilities and their treatment, but these do not differ from those described elsewhere, and their treatment is also similar to present accepted methods.—*S. A. Adland, M.D., Iowa City, Iowa.*

MECHANICAL FIXATION OF FRACTURES. Charles H. Bradford. *Proceedings of the Royal Society of Medicine*, XXXIV, Part II, 786 (Section of Orthopaedics, p. 37), 1941.

In addition to the three accepted methods of treating routine fractures—closed reduction, open reduction, and traction—the author suggests a fourth method derived from the principles of mechanical fixation. This is done by fixing the fracture at both ends by means of pins or screws, and then using these fixation units to accomplish reduction and immobilization of the fracture. The three important factors in the use of this method are:

1. The danger of contamination from the pins. This the author feels is minimized by strict asepsis, by normal tissue resistance, and by the fact that in this method of immobilization, the pins are rigidly fixed. (However, he does feel that, with the use of pins, the wound should be considered potentially infected.)

2. The problem of adapting a machine to the complicated manœuvres of fracture treatment. Although the surgeon may at first experience difficulty in substituting the complex apparatus for the familiar manipulations, repeated schooling will permit him to reproduce every manoeuvre.

3. The effect of such treatment on union of the fragments. The author warns that any treatment which tends to fix fracture ends in a position of distraction may delay or even prevent union. In the application of rigid pin fixation which allows no backward slipping, this is an important factor. To obviate this, the author releases the traction screw and forces the fragments together after reduction. He calls it "controlled impaction".

The advantages of this method are as follows:

1. It is a more powerful and more accurate means of reducing difficult fractures.
2. After the reduction is complete, it provides a vicelike form of fixation.
3. Such fixation properly applied avoids the delay in union produced by distraction.
4. It allows free ambulation from a very early period.

This mechanical fixation has proved its worth in the treatment of difficult fractures, particularly in those which have passed the stage where simple attempts at closed reduction would be effective.

The author states that inasmuch as war fractures are frequently compound and require open reduction, the Orr method does not offer a satisfactory solution, as it fails to meet the fracture requirements. The treatment suggested can readily be used in the presence of infection and can be combined with the closed-plaster method.

The importance of ambulatory treatment in time of war is stressed. Forty-one patients received this treatment, but follow-up studies have not been obtained because of the short postoperative period. Thirty-three of the cases involved the lower extremities. All the patients were seen comparatively late, the interval being over two weeks in twenty cases. Only three patients were seen within forty-eight hours. No detailed statistical results are given, but several cases with remarkable results are cited to illustrate the possibilities in the use of mechanical fixation.

Of the forty-one cases, a bone infection at the pin site developed in only one; this was a low-grade infection in a patient with a badly infected compound fracture. The patient responded to treatment.—*S. M. Albert, M.D., Iowa City, Iowa.*

SOBRE A FRATURA ISOLADA DA ESTILOIDE CUBITAL (On Isolated Fractures of the Styloid Process of the Ulna). Achilles de Araujo. *Revista Brasileira de Ortopedia e Traumatologia*, III, 71, 1941.

The author believes that this fracture has not been sufficiently studied. It was first mentioned by Voisin in 1833, and has been described in more detail by others since then. Although found to be more frequent than previously thought, this fracture has not attracted enough attention. In most of the modern and recent textbooks no mention of this fracture is found.

In the records of the author's clinic, only twelve such cases were registered in a period of twenty years. The fractures occurred only in males between fourteen and forty years of age, mostly on the left side, and involving more frequently the base of the styloid process. This observation corresponds to the facts obtained by other surgeons in the thirty-eight cases which the author could find in the literature. In most of the observations the fracture occurred as a result of an indirect trauma, from a sudden and violent rotation of the radial side of the hand. The author believes that the mechanism is one of avulsion produced by exaggerated tension of the ulnar collateral ligament of the wrist.

A fine description of the pathological anatomy and the symptomatology of this injury is followed by recommendations for treatment. Immobilization followed by physiotherapy is advocated. Infiltration by novocaine, as devised by Leriche, may be useful. In old cases with persistent pain, the removal of the non-united fragment may be necessary.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

FRATURAS DE HUMERO E LESÕES DO NERVO RADIAL (Fractures of the Humerus and Lesions of the Radial Nerve). Mario Marques Tourinho. *Revista Brasileira de Ortopedia e Traumatologia*, III, 144, 1942.

A short review of the literature is presented by the author, showing that in fractures of the humerus with the slightest involvement of the radial nerve, operative intervention is indicated and may even be imperative.

The author describes the possible complete anatomical and physiological section of the radial nerve. Two cases were treated by the author. In both cases surgical intervention followed shortly after the fracture. The radial nerve was not found to be anatomically severed, but its position in relation to the fractured fragments was such that the inclusion of the nerve in the future callus was possible. The author believes that every fracture with immediate signs of involvement of the radial nerve should be treated by open reduction and exploration of the radial nerve.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

RECONSTRUCCIÓN DE LOS LIGAMENTOS DE LA RODILLA. (PRESENTACION DE ENFERMOS) [Reconstruction of the Ligaments of the Knee. (Presentation of Patients)]. Antonio Bonadeo Ayrolo. *La Revista de Medicina y Ciencias Afines*, IV, 102, 1942.

The author presents three cases of reconstruction of the anterior cruciate ligament. Several innovations in technique are presented. A relatively small incision is used, which does not involve the patella, patellar tendon, or lateral ligaments, and which is said to produce much less trauma. A new cruciate ligament is made of fascia lata, which is placed through drill holes in the femur and tibia similarly to the manner used by American authors. An original drill guide is used to put the holes in the right place and at the right angle. The guide consists of a sleeve through which the drill point goes, and is made much like the Kirschner-wire guides, which are familiar. The sleeve, for guiding the drill, points at a pointed arm which is placed where the hole is intended to go. The device would seem to be very ingenious and valuable. The new cruciate ligament is anchored with silk sutures. The author repairs the lateral ligaments by simply resuturing them if this is possible. In one of the cases presented, the external lateral ligament was reconstructed, using the biceps tendon. This tendon was left attached to the fibula and a generous piece of it was dissected free proximally. It was then attached to the external condyle of the femur. Three cases are presented in detail, and excellent results were obtained in all three, according to the author. The article is well illustrated with drawings of the operative procedure using the guide, and photographs of the patients showing the end results.—*Louis W. Breck, M.D., El Paso, Texas.*

PLATYSPONDYLY. Henry G. Hadley. *Virginia Medical Monthly*, LXVIII, 357, 1941.

Platyspondyly is a term first used by Putti, and is derived from the Greek, meaning wide (platy) and vertebra (spondylos). This was mentioned by Nau who described it as *"vertébraux bilobés"*. Hemivertebra or platyspondyly is caused by failure or delay of fusion in the membranous stage of embryological development, while spina bifida may occur in any stage. Platyspondyly occurs only in the membranous stage. Lance describes three types. One usually occurs in the fourth or fifth lumbar, as in the cases of Putti. The second type is a widened vertebral body divided into two cuneiform segments with the apex centrally located, and the bases laterally,—frequently found in the thoracic and cervicothoracic areas. The third type is one in which the superior and inferior surfaces are concave in the center, while the intervertebral discs are convex and higher than normal.—*E. G. Lozano, M.D., Iowa City, Iowa.*

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Aneurysm of an Intercostal Artery with Simultaneous, Sarcomatous Destruction of an Adjacent, Dorsal Vertebra. Nils P. G. Edling. *Acta Radiol., XXII, 411, 1941* 221
Ankylosis of the Jaw: Cartilage Graft Restorations of the Joint: A New Operation. H. P. Pickerill. *Australian and New Zealand J. Surg., XI, 197, 1942* . . . 965
A proposito del osteoma-osteoide de Jaffe (About the Osteoid-Osteoma of Jaffe). J. L. Bado e P. L. Ibarz. *Revista Brasileira de Ortop. e Traumatol., II, 139, 1941* . . 237
Arthrodese da tibio-tarsica na paralysia infantil (Tibiotarsal Arthrodesis in Infantile Paralysis). Paulo Zander. *Revista Brasileira de Ortop. e Traumatol., II, 107, 1940* 491
Artrodese a Delahaye na cura da tuberculose do joelho (Delahaye's Arthrodesis in the Treatment of Tuberculosis of the Knee Joint). Barros Lima. *Arquivos Brasileiros de Cir. e Ortop., IX, 75, 1941* . . . 485
Atypical Giant Cell Tumor. Bradley L. Coley and Lawson E. Miller. *Am. J. Roentgenol., XLVII, 541, 1942* . . . 719
Back Disabilities Due to Strain of the Multifidus Muscle. Cases Treated by Novocain Injection. W. K. Livingston. *Western J. Surg. Obstet. Gynec., XLIX, 259, 1941* . . . 242
Base Hospital Management of Soft Tissue Injuries. B. K. Rank. *Australian and New Zealand J. Surg., XI, 171, 1942* . . . 963
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Caisson Disease (Compressed-Air Illness) of Bone with a Report of a Case. Valentine A. J. Swain. *British J. Surg., XXIX, 365, 1942* . . . 966
Calcaniectomía (dos observaciones) [Excision of the Os Calcis (Report of Two Cases)]. Sara Satanowsky. *Revista de Ortop. y Traumatol., X, 443, 1941* . . . 240
Calcareous Tendinitis (Peritendinitis Calcarea) at the Greater Trochanter of the Femur. Louis Kaplan. *Pennsylvania Med. J., XLV, 37, 1941* . . . 490
Calcification and Ossification of Vertebral Ligaments (Spondylitis Ossificans Ligamentosa): Roentgen Study of Pathogenesis and Clinical Significance. Albert Oppenheimer. *Radiology, XXXVIII, 160, 1942* . . . 732
Calcificaciones subdeltoideas (Subdeltoid Calcifications). Oscar R. Maróttoli y Arnoldo Didier. *Revista de Med. y Ciencias Afines, III, 495, 1941* . . . 735
Calcium Deposits in the Shoulder and Subacromial Bursitis. A Survey of 12,122 Shoulders. Boardman Marsh Bosworth. *J. Am. Med. Assn., CXVI, 2477, 1941* . . 227
Calcium, Phosphorus, Nitrogen and Magnesium Metabolism in Normal Young Chinese Adults. H. I. Chu; S. H. Siu; H. C. Hsu; H. C. Chao; and S. H. Chew. *Chinese Med. J., LIX, 1, 1941* . . . 968
Case of Leprosy with Charcot's Joint, A. R. Subramaniam. *J. South Indian Med., VII, 134, 1941* . . . 727
Causation of Fractures of the Neck of the Femur. E. Sandner and E. C. Thompson. *Med. J. Australia, II, 383, 1941* . . . 730
Cinematización del muñón de amputación (Cinematization of Amputation Stump). Francisco García Díaz. *Revista Española de Med. y Cir. de Guerra, IV, 1, 1941* . . . 733
Circulación del extremo superior del fémur (Circulation of the Proximal End of the Femur). Jorge Zarazaga. *Revista de Ortop. y Traumatol., XI, 26, 1941* . . . 494
Chordoma in a Thoracic Vertebra. C. J. Hansson. *Acta Radiol., XXII, 598, 1941* . . 955
Clinical Investigations with Curare in Organic Neurologic Disorders. A. E. Bennett. *Am. J. Med. Sciences, CCII, 102, 1941* . . . 481
Clinical Significance of Accessory Bones of the Foot, The. A. Gottlieb. *Western J. Surg. Obstet. Gynec., XLIX, 452, 1941* . . . 243
Colles's Fracture. William Darrach. *New England J. Med., CCXXVI, 594, 1942* . . 970
Comparison of the Effects of Disuse and Denervation upon Skeletal Muscle, A. G. Reid. *Med. J. Australia, II, 165, 1941* . . . 729

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Complete Roentgen Ray Studies of Gastro-Intestinal Tract in 400 Arthritics. E. W. Spackman; Theodore F. Bach; C. Wesler Scull; and Ralph Pemberton. *Am. J. Med. Sciences, CCII, 68, 1941* 480

Complicating Factors in the Treatment of Injuries to Menisci of the Knee Joint. Clay Ray Murray. *Am. J. Surg., LV, 262, 1942* 957

Compound Fractures. Harry C. Blair. *Northwest Med., XLI, 23, 1942* 730

Compound Fractures. Carleton Mathewson, Jr. *Western J. Surg. Obstet. Gynec., XLIX, 628, 1941* 497

Compound Fracture of the Leg. Fay Maclure. *Australian and New Zealand J. Surg., X, 354, 1941* 225

Compression of Brachial Plexus: The Scalenus Anticus Syndrome. Frederick Leet Reichert. *J. Am. Med. Assn., CXVIII, 294, 1942* 723

Compression of Cancellous Bone; Principal Manifestations in Head and Neck of Femur; Treatment by Connecting Drill Channels. Eugene J. Bozsan. *Am. J. Surg., LIII, 537, 1941* 483

Compression Fractures of the Dorsolumbar Vertebrae. John W. Gullikson and Edward R. Anderson. *Western J. Surg. Obstet. Gynec., XLIX, 576, 1941* 497

Concealed Ruptured Intervertebral Disks. A Plea for the Elimination of Contrast Mediums in Diagnosis. Walter E. Dandy. *J. Am. Med. Assn., CXVII, 821, 1941* 487

Congenital Pseudarthrosis of Tibia and Fibula. Report of Fifteen Cases. J. Hiram Kite. *Southern Med. J., XXXIV, 1021, 1941* 242

Consideraciones sobre el tratamiento de las lesiones del aparato extensor de la rodilla, basada sobre hechos clínicos (The Treatment of Lesions of the Extensor Apparatus of the Knee, Clinical Cases). Tadeo Sokolowsky. *Anales de Cir., VII, 63, 1941* .. 484

Consideration of Certain Dimensional Factors Involved in the Internal Fixation of the Femoral Neck, A. D. J. Glissan. *Australian and New Zealand J. Surg., X, 368, 1941* 225

Contribution to the Knowledge of Congenital Dislocation of the Hip Joint. Late Results of Closed Reduction and Arthrographic Studies of Recent Cases. Erik Severin. *Acta Chir. Scandinavica, LXXXIV, Supplementum 63, 1941* 219

Costellas cervicaes (Cervical Ribs). Achilles de Araujo. *Revista Brasileira de Ortop. e Traumatol., II, 186, 1941* 237

Coxa Plana, with Special Reference to Its Pathology and Kinship. H. Jackson Burrows. *British J. Surg., XXIX, 23, 1941* 225

Critical Survey of Ten Years' Experience with Fractures of the Neck of the Femur, A. Mather Cleveland. *Surg. Gynec. Obstet., LXXIV, 529, 1942* 738

Da radiotherapia na peri-arthrite escapulo-humeral (X-Ray Therapy in Scapulohumeral Periarthritis). Achilles de Araujo e Carlos Osborne. *Revista Brasileira de Ortop. e Traumatol., II, 235, 1941* 492

Der tuberkulöse Rheumatismus (Tuberculous Rheumatism). C. Frugoni. *Ztschr. f. Rheumaforschung, IV, 203, 1941* 244

Development of Sarcoma in Myositis Ossificans, The. Report of Three Cases. George T. Pack and Ralph R. Braund. *J. Am. Med. Assn., CXIX, 776, 1942* 969

Diagnosis of Sciatica and Low Back Pain Due to Herniation of Intervertebral Disks. G. E. Haggart. *Surg. Clin. North Am., XXI, 889, 1941* 496

Die Bedeutung des Rheumatismus nodosus innerhalb des Rheumaproblems (The Significance of Nodules in Relation to the Study of Rheumatic Disease). A. Welz. *Ztschr. f. Rheumaforschung, III, 510, 1940* 244

Die Frontale Wirbelkörperspalte (Frontal Fissure of the Vertebrae). Folke Knutsson. *Acta Radiol., XXI, 597, 1940* 220

Die Goldbehandlung der chronischen Arthritis unter besonderer Berücksichtigung der Komplikationen (Gold Therapy in Chronic Arthritis with Particular Reference to Complications). Fredrik Sundelin. Lund, Sweden, Håkan Ohlssons (*Acta Med. Scandinavica, Supplementum, CXVII*), *1941* 479

Disuse Atrophy of Skeletal Muscle. J. C. Eccles. *Med. J. Australia, II, 160, 1941* .. 729

Dupuytren's Contracture. Arthur Rocyn-Jones. *Med. Press and Circ., CCVI, 14, 1941* 232

Dystrophia Myotonica in Infants and Children. Otto Maas. *British J. Child. Diseases, XXXVIII, 59, 1941* 721

Eine anatomische Studie über lumbale Zwischenwirbelscheibenprotusionen und Zwischenwirbelscheibenbrüche in die Foramina intervertebralia hinein (Anatomical Study of Protrusions of the Lumbar Intervertebral Disc and Ruptures of the Disc into the Intervertebral Foramina). K. Lindblom. *Acta Radiol., XXII, 711, 1941* 956

El pie plano por insuficiencia en los heridos de guerra (Flat-Foot from Insufficiency after War Wounds). Manuel Cardenas. *Revista Española de Med. y Cir. de Guerra, IV, No. 33, p. 257, 1941* 734

End Results of Synovectomy of the Knee Joint. Ralph K. Ghormley and David M. Cameron. *Am. J. Surg., LIII, 455, 1941* 482

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Enfermedad de Hoffa (Hyperplasia of the Retropatellar Fat). Vicente J. Bértola y Dante J. Baistrocchi. *Bol. y Trab. Soc. de Cir. de Córdoba, II, 313, 1941* 966

Estudio experimental de la luxación rotatoria del atlas y su aplicación a los conocimientos actuales (Experimental Study of Rotary Luxation of the Atlas). Enrique H. Lagomarsino y Héctor Dal Lago. *Revista de Ortop. y Traumatol., X, 121, 1940* .. 239

Experience of the Canadian Army and Pensions Board with Amputations of the Lower Extremity, The. W. E. Gallie. *Ann. Surg., CXIII, 925, 1941* 958

Experiences with Epidural Contrast Investigation of the Lumbo-Sacral Canal in Disc Prolapse (Perabrodil). Folke Knutsson. *Acta Radiol., XXII, 694, 1941* .. 955

External Pin Fixation for Fractures of the Mandible. Rainsford Mowlem; J. L. Dudley Buxton; Alexander B. MacGregor; and John N. Barron. *Lancet, II, 391, 1941* 231

Fractura de Bennet (Bennett's Fracture). Héctor Ordóñez Ferreyra y Héctor Martinez Carranza. *Bol. y Trab. Soc. de Cir. de Córdoba, II, 263, 1941* 965

Fractures of the Astragalus. Harold B. Boyd and Robert A. Knight. *Southern Med. J., XXXV, 160, 1942* 736

Fractures of the Forearm and Elbow in Children. An Analysis of Three Hundred and Sixty-Four Consecutive Cases. Augustus Thorndike, Jr., and Charles L. Dimmler, Jr. *New England J. Med., CCXXV, 475, 1941* 490

Fractures of the Hip. The Present Status of Its Treatment. R. T. Hudson. *Southern Med. J., XXXIV, 1154, 1941* 495

Fractures of the Humerus Treated by the Hanging Cast. R. Arnold Griswold; D. C. Hucherson; and E. C. Strode. *Southern Med. J., XXXIV, 777, 1941* 241

Fractures of the Lower End of the Radius and Ulna. Arthur G. Ord. *Med. Press and Circ., CCV, 496, 1941* 232

Fractures of the Patella. G. O. Tippett. *Med. Press and Circ., CCVI, 162, 1941* 232

Fractures of the Pelvis. With Special Reference to Associated Fractures of the Sacrum. Warren W. Furey. *Am. J. Roentgenol., XLVII, 89, 1942* 717

Fractures of the Spine. A Study of Two Hundred Cases. S. Bernard Wortis and Lewis I. Sharp. *J. Am. Med. Assn., CXVII, 1585, 1941* 488

Fractures of the Spine after Metrazol Convulsive Therapy and Other Convulsive States. M. M. Pearson and H. W. Ostrum. *Am. J. Roentgenol., XLIV, 736, 1940* 221

Fractures Sustained in War. William Darrach. *Am. J. Surg., LVI, 341, 1942* 720

Fraturas da coluna dorso-lombar (Fractures of the Thoracolumbar Spine). Bruno Maia. *Bol. do Instituto de Assistencia Hospitalar, II, 44, 1941* 485

Fraturas de humero e lesões do nervo radial (Fractures of the Humerus and Lesions of the Radial Nerve). Mario Marques Tourinho. *Revista Brasileira de Ortop. e Traumatol., III, 144, 1942* 972

Fresh Compound Fractures. Treatment by Sulfonamides and by Internal Fixation in Selected Cases. Willis C. Campbell and Hugh Smith. *J. Am. Med. Assn., CXVII, 672, 1941* 486

Genesis of Rachitic Exostoses of the Tibia, The. Z. A. Landress. *Khirurgiya, V, 90, 1941* 727

Gold Infections in the Treatment of Arthritis. Doris M. Baker. *Med. Press and Circ., CCVI, 419, 1941* 490

Haemangioma of the Hand, Involving Phalangeal Bones, with Distinctive Radiological Appearance. Konrad Hirschfeld. *Australian and New Zealand J. Surg., XI, 136, 1941* 962

Hallux Valgus. Survey of End Results of Various Operative Procedures for Correction of Hallux Valgus Performed at the Hospital During the Past Ten Years (1931–1940). Louis S. Nelson and Emanuel Kaplan. *Bull. Hosp. Joint Diseases, III, 17, 1942* .. 486

Heridas de guerra de la articulación de la rodilla (War Wounds of the Knee Joint). M. García Portela. *Revista Española de Med. y Cir. de Guerra, IV, No. 29, p. 35, 1941* 734

Historical Review of Metals Used in Orthopedic Surgery. F. Walter Carruthers. *Southern Med. J., XXIV, 1223, 1941* 495

Injuries of the Internal Semilunar Cartilage. Possible Predisposition toward; Symptoms and Treatment. Edward K. Cravener and Donald G. MacElroy. *J. Am. Med. Assn., CXVII, 1695, 1941* 488

Insufficiency Fracture of the Tibia Resembling Osteogenic Sarcoma. George E. Pfahler. *Am. J. Roentgenol., XLV, 209, 1941* 221

Intracapsular Fractures of the Neck of the Femur. Final Results of 75 Consecutive Cases Treated by the Closed Method of Pinning. A. L. Eyre-Brooke and K. H. Pridie. *British J. Surg., XXIX, 115, 1941* 226

Intraspinal Operations in Compensation Cases. Arthur Ecker. *J. Am. Med. Assn., CXIX, 128, 1942* 725

Irrigation of Wounds with Hot Sulfanilamide Solution. Fred R. Adams. *Med. Press and Circ., CCV, 318, 1941* 231

Ischiofemoral Arthrodesis. H. A. Brittain. *British J. Surg., XXIX, 93, 1941* 226

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Kenny Treatment of Infantile Paralysis during the Acute Stage, The. Philip Lewin. *Illinois Med. J., LXXXI, 281, 1942* 723

Late Results in Benign Giant-Cell Tumor of Bone Obtained by Radiation Therapy. T. Leucutia; E. R. Witwer; and George Belanger. *Radiology, XXXVII, 1, 1941* 237

Local Use of Sulfathiazole in the Treatment of Staphylococcal Infections, The. Preliminary Report. W. W. Spink and J. R. Paine. *Minnesota Med., XXIII, 615, 1940* 233

Lumbar Puncture. Its Potential Role in the Production of Injuries to the Intervertebral Disks. Donald Munro and Warren G. Harding, 2d. *J. Am. Med. Assn., CXIX, 482, 1942* 968

Luxación acromioclavicular. Dispositivo para su tratamiento y trabajo experimental (Acromioclavicular Dislocation. A Method of Treatment and Experimental Work). Domingo Muscolo. *Revista de Ortop. y Traumatol., XI, 69, 1941* 493

Luxación hacia adelante de la extremidad inferior del cubito. Secuela de fractura del tercio inferior del radio (Forward Dislocation of the Distal End of the Ulna Following Fractures of the Distal Third of the Radius). Herbert Cagnoli. *Revista Brasileira de Ortop. e Traumatol., II, 365, 1941* 492

Luxación recidivante de hombro: Puente osteoplástico córacoglenoideo. Operación de Ricardo Finochietto (Recurrent Dislocation of the Shoulder: An Osteoplastic Bridge from the Coracoid to the Glenoid. Ricardo Finochietto's Operation). V. J. Bértola. *Revista de Med. y Ciencias Afines, II, 545, 1940* 237

Madelung's Deformity (Case Report). J. Marsh Frere. *Southern Med. J., XXXV, 168, 1942* 736

Malignant Tumors of Synovial Origin. Crenshaw D. Briggs. *Ann. Surg., CXV, 413, 1942* 960

Malignant Tumours of Tendon Sheaths. E. S. J. King. *Australian and New Zealand J. Surg., X, 338, 1941* 224

Manipulation of the Dorsal Vertebrae. F. Guy Beauchamp. *Rheumatism, II, 36, 1940* 240

March Fracture. George R. Krause. *Radiology, XXXVIII, 473, 1942* 732

Mechanical Fixation of Fractures. Charles H. Bradford. *Proc. Roy. Soc. Med., XXXIV, Part II, 786 (Sect. Orthop., p. 37), 1941* 970

Method of Treatment of Burns and Wounds, A. John Bunyan. *Med. Press and Circ., CCVI, 103, 1941* 489

Minor Causalgia Following Injuries and Wounds. John Homans. *Ann. Surg., CXIII, 932, 1941* 959

Monteggia Fractures. Arthur Naylor. *British J. Surg., XXIX, 323, 1942* 722

Muscle Behavior Following Infantile Paralysis. Herbert E. Hipps. *Am. J. Surg., LIII, 314, 1941* 482

Neck Pain. The Laminograph as an Aid to the Diagnosis of Atlanto-Occipital Lesions. Frederick A. Jostes. *J. Am. Med. Assn., CXVIII, 353, 1942* 724

Neumofascia de la rodilla (Air Roentgenography of the Knee). Angel Matute V. y Jesus Salas. *Analecta Méd., I, 9, 1940* 484

Neurodocitis del nervio cubital en el codo (Ulnar Neuritis at the Elbow). Valentine C. Girardi. *Revista de Ortop. y Traumatol., X, 15, 1940* 239

Neurologic Syndromes Accompanying Developmental Anomalies of Occipital Bone, Atlas and Axis. Carl E. List. *Arch. Neurol. and Psychiat., XLV, 577, 1941* 224

Newer Drugs in Treatment of Arthritis. K. K. Sherwood. *Northwest Med., XXXIX, 452, 1940* 235

Nicola Operation for Recurrent Dislocation of the Shoulder, The. A Review of Twenty-Six Cases. R. Beverly Raney and Oscar L. Miller. *Southern Med. J., XXXV, 529, 1942* 737

Observations and Problems on Operation for Lesions of the Semilunar Cartilage. Felix Mandl. *J. Internat. Coll. Surgeons, V, 63, 1942* 725

Occult Fractures. Roland Hammond and Denis S. O'Connor. *J. Am. Med. Assn., CXVII, 500, 1941* 229

On Bipartite Os Naviculare Pedis. Erik de Fine Licht. *Acta Radiol., XXII, 377, 1941* 220

On Calvé's Disease (So-Called Flat Vertebra). L. L. Lutrovnik. *Khirurgiya, V, 85, 1941* 727

On Movements of Fluid inside the Cerebro-Spinal Space. Haakon Reitan. *Acta Radiol., XXII, 762, 1941* 956

Operative Procedure in Intervertebral Disk Protrusions, The. H. Olivercrona. *Acta Radiol., XXII, 743, 1941* 956

Neuropathic Arthropathy of the Ankle Joint Resulting from Complete Severance of the Sciatic Nerve. Graham Kernwein and W. F. Lyon. *Ann. Surg., CXV, 267, 1942* 959

Palliative Treatment of Irreducible Congenital Dislocations of the Hip. Charles J. Frankel. *Southern Med. J., XXXV, 404, 1942* 737

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Plastiche a distanza con lamine di gomma in lesioni sperimentali di fasci nervosi (Bridge Plastic with Sheet Rubber in Experimental Lesions of Nerve Bundles). G. Giangrasso. *Annali Italiani di Chir., XIX, 561, 1940* 222

Plastiche peritendinee sperimentali con lamine di gomma (Experimental Peritendon Plastic with Sheet Rubber). G. Giangrasso. *Annali Italiani di Chir., XIX, 766, 1940* 223

Platyspondyly. Henry G. Hadley. *Virginia Med. Monthly, LXVIII, 357, 1941* ... 972

Plight of the Arthritic, The. Russell L. Cecil. *J. Med. Assn. Georgia, p. 318, July 1941* 230

Post-Traumatic Painful Osteoporosis. A Clinical and Roentgenological Entity. Louis G. Herrmann; Harold G. Reineke; and John A. Caldwell. *Am. J. Roentgenol., XLVII, 353, 1942* 718

Post-Traumatic Para-Articular Ossification of the Knee Joint (Pelligrini-Stieda's Disease). J. Kulowski. *Am. J. Roentgenol., XLVII, 392, 1942* 719

Potentiation of the Sulfonamides in the Local Therapy of Wounds and Surgical Infections by the Use of Oxidants, The. Harold A. Goldberger. *Am. J. Surg., LVI, 353, 1942* 720

Preliminary Report on Internal Derangements of the Knee Joint Treated at an Australian General Hospital, Australian Imperial Force Abroad, to May 31, 1941. R. V. Graham. *Australian and New Zealand J. Surg., XI, 185, 1942* 964

Prevention of Hammer-Toe Bursitis. Kenneth McFadyean. *Lancet, I, 474, 1942* 728

Primary Malignant Tumors of Bone. Henry W. Meyerding and Jorge E. Valls. *J. Am. Med. Assn., CXVII, 237, 1941* 228

Principles of Fracture Treatment, The. A. T. Andreasen. *J. Indian Med. Assn., XI, 158, 1942* 969

Pseudofractures in Diseases Affecting the Skeletal System. John D. Camp and J. A. L. McCullough. *Radiology, XXXVI, 651, 1941* 236

Radiological Appearances of Osteoarticular Lesions in Leprosy studied through Radiology. Mario Soares Da Veiga. *Antiseptic, XXXVIII, 579, 1941* 485

Recent Advances in the Diagnosis and Treatment of Ruptured Intervertebral Disks. Walter E. Dandy. *Ann. Surg., CXV, 514, 1942* 961

Reconstrucción de los ligamentos de la rodilla. (Presentación de enfermos) [Reconstruction of the Ligaments of the Knee. (Presentation of Patients)]. Antonio Bonadeo Ayrolo. *Revista de Med. y Ciencias Afines, IV, 102, 1942* 972

Results of Röntgen Treatment of Spondylosis Rhizomelica (Spondylarthritis Ankylopoetica). J. van Ebbenhorst Tengbergen and H. J. N. Dekhers. *Acta Radiol., XXII, 522, 1941* 480

Rheumatismus, Endokarditis und Tuberkulose im Kindesalter (Rheumatic Fever, Endocarditis, and Tuberculosis in Childhood). E. Glanzmann. *Ztschr. f. Rheumaforschung, IV, 169, 1941* 497

Rigenerazione segmentaria ossea mediante innesti eteroplastici. Ricerche sperimentali (Segmentary Regeneration of Bones by Means of Heteroplastic Grafts). Vincenzo Liberti. *Annali Italiani di Chir., XIX, 389, 1940* 222

Roentgen Findings in Increased Lead Absorption Due to Retained Projectiles, The. Hyman R. Senturia. *Am. J. Roentgenol., XLVII, 381, 1942* 718

Roentgen Therapy for Rheumatoid Arthritis of the Spine (Marie-Strümpell Arthritis; Spondylitis Rhizomelique). C. J. Smyth; R. H. Freyberg; and Isadore Lampe. *J. Am. Med. Assn., CXVII, 826, 1941* 487

Röntgenbehandlung der rheumatischen Krankheiten (Roentgenotherapy in Rheumatic Diseases). Gunnar Kahlmeter. *Ztschr. f. Rheumaforschung, IV, 57, 1941* .. 244

Roentgenologic Changes in the Bones in Cases of Pseudohypertrophic Muscular Dystrophy. Bernard S. Epstein and Joseph L. Abramson. *Arch. Neurol. and Psychiat., XLVI, 868, 1941* 961

Salvaging of Fracture of the Femoral Neck, The. Royal Whitman. *Lancet, I, 378, 1942* 728

Scalenus Anticus Syndrome, The. Bernard D. Judovich and William Bates. *J. Internat. Coll. Surg., V, 26, 1942* 725

Sciatica from Aneurysm of Sciatic Artery. John F. LeCocq. *Northwest Med., XLI, 121, 1942* 731

Septic Spondylitis. Report of Seven Cases. Lars Holmberg. *Acta Chir. Scandinavica, LXXXIV, 479, 1941* 218

Sequel of Knee Ligament Strain: Pellegrini-Stieda's Disease (Metacondylar Traumatic Osteoma), A. W. R. Hamsa. *Nebraska State Med. J., XXVII, 62, 1942* .. 969

Sequelae to Injuries of the Bones and Joints, The. St. J. D. Buxton. *Med. Press and Circ., CCV, 376, 1941* 490

Sequelae to Nerve Injuries, The. Harry Platt. *Med. Press and Circ., CCV, 371, 1941* 231

Serious Complications of Ruptured Intervertebral Disks. Walter E. Dandy. *J. Am. Med. Assn., CXIX, 474, 1942* 968

PAGE

Seudoartrosis del escafoides carpiano, tratamiento por injerto óseo (Non-Union of Fractures of the Carpal Scaphoid, Treatment by Means of a Bone Graft). Oscar R. Maróttoli. *Anales de Cir., VII, 31, 1941* 484, 957

Shoulder and Elbow Lesions of the Professional Baseball Pitcher. George E. Bennett. *J. Am. Med. Assn., CXVII, 510, 1941* 230

Simple Skeletonized Plaster Splint for the Cervical Spine, A. Sam W. Banks; Edward L. Compere; and Charles Watson. *J. Am. Med. Assn., CXIX, 631, 1942.* 969

Skeletal and Other Changes Found in a Case of Suprasellar Cyst of Rathke's Pouch, The. R. A. Rowlands and S. L. Simpson. With a Pathological Report by Dorothy S. Russell and H. M. Turnbull. *British J. Surg., XXIX, 304, 1942* 722

Slipping of the Upper Femoral Epiphysis. M. Beckett Howorth. *Surg. Gynec. Obstet., LXXIII, 723, 1941* 495

Sobre a fratura isolade da estiloide cubital (On Isolated Fractures of the Styloid Process of the Ulna). Achilles de Araujo. *Revista Brasileira de Ortop. e Traumatol., III, 71, 1941* 971

Sobre un caso de osteomielitis de la diáfisis femoral en apariencia primitiva (Report of a Case of Typhoid in Which the First Manifestation Was in the Femoral Diaphysis). R. A. Marotta y Fernando M. Bustos. *Revista de Med. y Ciencias Afines, III, 644, 1941* 736

Some Cases of Soldier's Fracture. Jens Munck Nordentoft. *Acta Radiol., XXI, 615, 1940* 220

Spondylolisthesis Affecting the Fourth Lumbar Vertebra. William MacL. E. Topping. *British J. Radiol., XIV, 162, 1941* 721

Spontaneous Fracture of the Apparently Normal Neck of the Femur. Kenneth S. Mullard. *British J. Surg., XXIX, 241, 1941* 721

Statistical and Roentgen Analysis of Two Hundred Cases of Bone and Joint Tuberculosis, A. Louis Nathanson and William Cohen. *Radiology, XXXVI, 550, 1941* 235

Subcutaneous Rupture of the Iliopsoas Muscle. A Report of Three Cases. Gunnar Strandell. *Acta Chir. Scandinavica, LXXXVI, 149, 1942.* 954

Subtalar Dislocations. Case Report of the Inward Type. Robert A. Wise. *Ann. Surg., CXV, 445, 1942* 960

Sulle conseguenze dell'azione del freddo nelle epifisi di animali in accrescimento (On the Action of Refrigeration upon the Epiphyses of Animals during Growth). G. B. Cengiarotti. *Annali Italiani di Chir., XIX, 607, 1940* 223

Supraspinatus Syndrome, The. Symptomatology, Pathology and Repair. David M. Bosworth. *J. Am. Med. Assn., CXVII, 422, 1941* 229

Surgical Experiences in the Middle East. Julian Smith. *Australian and New Zealand J. Surg., XI, 153, 1942* 962

Surgical Treatment of Leg Length Discrepancies, The. Paul H. Harmon and William M. Krigsten. *Illinois Med. J., LXXIX, 300, 1941* 227

Synovial Sarcomas in Joints, Bursae, and Tendon Sheaths. A Clinical and Pathological Study of Sixteen Cases. Dominic A. De Santo; Robert Tennant; and Paul D. Rosahn. *Surg. Gynec. Obstet., LXXII, 951, 1941* 496

Three C's of Surgical Healing. Edwin A. Nixon. *Northwest Med., XLI, 129, 1942* .. 731

Three Patients Showing the Result of Treatment of Carpal Dislocation. F. A. Simmonds. *Proc. Roy. Soc. Med., XXXIV, 507 (Sect. Orthop., p. 11), 1941* 491

Time of Appearance and Fusion of Ossification Centers as Observed by Roentgenographic Methods. H. Flecker. *Am. J. Roentgenol., XLVII, 97, 1942* 717

Transplantation of Fibula for Nonunion of Tibia: Report of Case. M. S. Henderson and W. H. Bickel. *Proc. Staff Meet. Mayo Clin., XVI, 510, 1941* 491

Transplants to the Thumb to Restore Function of Opposition: End Results. C. E. Irwin. *Southern Med. J., XXXV, 257, 1942* 737

Transverse Osteotomy in Ununited Fractures of the Femoral Neck. S. A. Jahss and B. J. Mintz. *Bull. Hosp. Joint Diseases, II, 143, 1941* 226

Tratamiento quirúrgico de la luxación congénita de la rótula (Surgical Treatment of Congenital Dislocation of the Patella). Carlos Urrutia U. *Revista de Ortop. y Traumatol., IX, 203, 1940* 238

Traumatic Conditions of the Wrist. F. G. Hodgson. *J. Med. Assn. Georgia, XXXI, 66, 1942* 726

Treatment of Arthritic Joints. Robert J. Joplin and George J. Baer. *J. Am. Med. Assn., CXVIII, 937, 1942* 724

Treatment of Chronic Arthritis with Gold Sodium Thiosulphate. John C. Thompson and C. K. Elliott. *Nebraska State Med. J., XXVI, 44, 1941* 234

Treatment of Compound Fractures of the Femur, The. R. Weeden Butler. *Med. Press and Circ., CCVI, 285, 1941* 489

Treatment of Fractures of the Femoral Neck in the Aged, The. Hermán de Las Casas. *J. Internat. Coll. Surgeons, V, 98, 1942* 726

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Treatment of Fractures of the Lower Third of the Humerus. F. Adelbert Hoshall. *Southern Med. J., XXXIV, 1152, 1941* ... 495
Treatment of Intracapsular Fractures of the Femoral Neck. A. S. Blundell Bankart. *Lancet, I, 250, 1942* ... 728
Treatment by Local Injections of Some Forms of Low Back Pain, Sciatica and Lumbago, The. An Editorial. *Rheumatism, II, 1940* ... 494
Treatment of Neurogenic Urinary Incontinence with Trasentin, The. Irving Simons. *Bull. Hosp. Joint Diseases, III, 26, 1942* ... 723
Trochanteric Fractures. Harry D. Morris. *Southern Med. J., XXXIV, 571, 1941* 241
Trochanteric Osteotomy for Ununited Fractures of the Neck of the Femur. J. S. Speed and Hugh Smith. *Southern Med. J., XXXIV, 798, 1941* ... 241
Tuberculosis of the Knee in Adults. H. J. Wyckoff. *Northwest Med., XLI, 120, 1942* 730
Tuberculosis of the Long Bones. The Importance of Its Differential Diagnosis from Pyogenic Osteomyelitis. Merrill Coleman Mensor. *Western J. Surg. Obstet. Gynec., L, 187, 1942* ... 738
Tuberculosis of the Spine: Observations on Localization, Extension and Healing—Their Bearing on Diagnosis and Treatment. J. V. de los Santos. *Bull. Quezon Institute, I, 283, 1941* ... 966
Tumores óseos a células gigantes (Giant-Cell Tumors of Bone). Domingo T. Muscolo. *Revista de Ortop. y Traumatol., IX, 301, 1940* ... 238
Über Calcaneusfrakturen (Fractures of the Calcaneum). Thore Olovson. *Acta Orthop. Scandinavica, XI, 199, 1940* ... 219
Über die Injektionsbehandlung bei Ischias (The Injection Treatment for Sciatica). Ernst Vaubel. *Ztschr. f. Rheumaforschung, IV, 34, 1941* ... 243
Über intertrochantere Osteotomie statt subtrochanterer (Intertrochanteric Osteotomy Instead of Subtrochanteric). Nils Silfverskiöld. *Acta Chir. Scandinavica, LXXXVI, 379, 1942* ... 955
Um novo tipo de placa para osteosintese (A New Type of Plate for Bone Fixation). Octavio Caputti. *Revista Brasileira de Ortop. e Traumatol., II, 274, 1941* ... 492
Uncomplicated Fractures of Ribs and Major Injuries of the Chest Wall, Treatment by Infiltration with Local Anesthetic. Paul H. Harmon; Dan R. Baker; and Robert D. Kornegay. *J. Am. Med. Assn., CXVIII, 30, 1942* ... 488
Unusual Case of Loose Body in the Elbow-Joint, An. N. Vere-Hodge. *British J. Surg., XXIX, 274, 1941* ... 722
Use of Gold in Rheumatoid Arthritis, The. E. R. Gardner. *Med. Record, CLIII, 321, 1941* ... 233
Use of Sulfanilamide and Sulfathiazole in Orthopedic Surgery, The. J. Albert Key. *J. Am. Med. Assn., CXVII, 409, 1941* ... 229
Use of Sulfonamides in Clean Operative Wounds, The. J. Albert Key. *Southern Med. J., XXXV, 55, 1942* ... 495
Use of Surface Anesthesia in the Treatment of Painful Motion, The. Hans Kraus. *J. Am. Med. Assn., CXVI, 2582, 1941* ... 227
Use of Vitallium in Surgery with Special Reference to Cup Arthroplasty, The. W. H. Cole. *Proc. Roy. Soc. Med., XXXIV, 779 (Sect. Orthop., p. 29), 1941* ... 731
Vertebra Plana (Calvé). Report of Two Cases. F. Y. Kuhlman. *Am. J. Roentgenol., XLVI, 203, 1941* ... 482
Vitamin B_6 (Pyridoxine Hydrochloride) in the Treatment of Pseudohypertrophic Muscular Dystrophy among Children. Haddow M. Keith. *J. Pediat., XX, 200, 1942* 726
War Wounds. John J. Moorhead. *Am. J. Surg., LVI, 338, 1942* ... 719

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Boletines y Trabajos de la Sociedad de Cirugía de Córdoba (Argentina), II, No. 9, 1941: III, No. 1, 1942.

Bulletin of the Hospital for Joint Diseases (New York, N. Y.), III, No. 3, 1942.

The University of Chicago Announcements. The School of Medicine, Sessions of 1942–1943. XLII, No. 13. Chicago, 1942.

Cleveland Clinic Quarterly, IX, No. 3, 1942.

Harper Hospital Bulletin (Detroit, Michigan), I, Nos. 7, 9, 1942.

Hospital for Joint Diseases (New York, N. Y.), Thirty-Fifth Annual Report, 1941.

The Johns Hopkins University Circular. School of Hygiene and Public Health. Catalogue Number, 1942–1943 (New Series, No. 6). Baltimore, 1942.

Médica (Matanzas, Cuba), I, Núm. 4, 1942.

The National Foundation for Infantile Paralysis, Inc. (New York, N. Y.):

The President's Address, by Basil O'Connor, delivered at the Second Annual Medical Meeting of The National Foundation for Infantile Paralysis, Inc., December 4, 1941.

The Story of The National Foundation for Infantile Paralysis, Inc., 1941. Annual Report, 1941.

Proceedings of the Thirty-Fifth Annual Convention of The Association of Life Insurance Presidents (New York, N. Y.), 1941.

Proceedings of the Staff Meetings of the Mayo Clinic (Rochester, Minnesota), XVII, Nos. 19, 20, 22, 23, 24, 25, 26, 27, 29, 1942.

Revista Cubana de Obstetricia y Ginecología (La Habana, Cuba), IV, Nos. 5–6, 7, 1942.

Roche Review (Nutley, New Jersey), VI, Nos. 11, 12, 1942.

The Rockefeller Foundation (New York, N. Y.), International Health Division Annual Report, 1941.

La Tribuna Médica (Habana, Cuba), XV, No. 268, 1942.

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